NATIONAL MARROW DONOR PROGRAM®

BE THE MATCH®

May 06, 2014

LCDR Christopher Steele
Office of Naval Research
Code 34 – Warfighter Performance
875 N. Randolph St.
Arlington, VA 22203-1995

Subject: Final Report of the National Marrow Donor Program®

Reference: Grant #N00014-11-1-0339 between the Office of Naval Research and the National Marrow Donor Program

Dear LCDR Steele:

In accordance with the requirements of the Referenced Cooperative Agreement, the enclosed subject document is provided as the Final Report for each statement of work task item of the Grant for the period of January 01, 2011 through December 31, 2012.

With this submittal of the Final Report, the National Marrow Donor Program has satisfied the all reporting requirements of the above referenced Grant.

Should you have any questions as to the scientific content of the tasks and the performance activity of this progress report, you may contact our Chief Medical Officer – Dennis Confer, MD directly at 612-362-3425.

Please direct any questions pertaining to the Grant to my attention (612-362-3403 or at cabler@nmdp.org).

Sincerely,

Carla Abler-Erickson

Carla Abler-Erickson, M.A.
Contracts Manager

Enclosure: One (1) copy of subject document

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
06-05-2014	Final	Jan 2011 – Dec 2012

4. TITLE AND SUBTITLE
Development of Medical Technology for Contingency Response to Marrow Toxic Agents - Final Performance/Technical Report for January 01, 2011 to December 31, 2012

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N00014-11-1-0339

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
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5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
Project 1, 2, 3, 4

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Marrow Donor Program
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8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
875 N. Randolph St.
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10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSORING/MONITORING AGENCY REPORT NUMBER
N/A

12. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES
N/A

14. ABSTRACT

1. Contingency Prepardness: Collect information from transplant centers, build awareness of the Transplant Center Contingency Planning Committee and educate the transplant community about the critical importance of establishing a nationwide contingency response plan.

2. Rapid Identification of Matched Donors : Increase operational efficiencies that accelerate the search process and increase patient access are key to preparedness in a contingency event.

3. Immunogenetic Studies: Increase understanding of the immunologic factors important in HSC transplantation.

4. Clinical Research in Transplantation: Create a platform that facilitates multicenter collaboration and data management.

15. SUBJECT TERMS
Research in HLA Typing, Hematopoietic Stem Cell Transplantation and Clinical Studies to Improve Outcomes

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	Same as Report	108	Dennis L. Confer, MD – Chief Medical Office
U	U	U			19b. TELEPONE NUMBER (*Include area code)* 612.362.3425

National Marrow Donor Program® N00014-11-0339
HLA Typing for Bone Marrow Transplantation
FINAL REPORT
January 1, 2011 – December 31, 2012

National Marrow Donor Program® N00014-11-1-0339
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ACRONYM LIST

AABB	AABB, formerly the American Association of Blood Banks
AAFA	African American (NMDP race code)
ABD	Antigen Binding Domain
AC	Apheresis Center
AFA	African American
AFB	African
AGNIS®	A Growable Network Information System
AIM	Ancestry Informative Markers
AINDI	South Asian
AISC	American Indian South or Central
ALANAM	Alaska Native or Aleut
ALDH	Aldehyde Dehydrogenase
ALDHbr	Aldehyde Dehydrogenase bright
ALL	Acute Lymphoblastic Leukemia
AMIND	North American Indian
AML	Acute Myelogenous Leukemia
API	Asian Pacific Islander
ARC GIS	ArcGIS is a brand name: GIS = Geographical Information System
ASBMT	American Society for Blood and Marrow Transplantation
ASH	American Society of Hematology
ASHG	American Society of Human Genetics
ASHI	American Society for Histocompatibility and Immunogenetics
ASPR	Assistant Secretary for Preparedness and Response
B2B	Business to Business
BARDA	Biomedical Advanced Research and Development Authority
BBMT	Biology of Blood and Marrow Transplant
B-LCLs	B-Lymphocytic Cell Lines
BMDW	Bone Marrow Donors Worldwide
BMT	Bone Marrow Transplant/Transplantation
BMT CTN	Blood and Marrow Transplant - Clinical Trials Network
BODI	Business Objects Data Integrator
BRIDG	Biomedical Research Integrated Domain Group
caDSR	Cancer Data Standards Repository
CARB	Black Caribbean
CARHIS	Caribbean Hispanic
CARIBI	Caribbean Indian
CAU	Caucasian
CB	Cord Blood
CBB	Cord Blood Bank
CBT	Cord Blood Transplantation
CBU	Cord Blood Unit

CC	Collection Center
CEM	Certified Emergency Manager
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CFU	Colony Forming Unit
CIBMTR®	Center for International Blood & Marrow Transplant Research
CIO	Chief Information Officer
CML	Chronic Myelogenous Leukemia
CMO	Chief Medical Officer
CMS	Center for Medicare and Medicaid Services
CRIS	Computerized Repository Inventory System
CSF	Colony Stimulating Factors
CT	Confirmatory Testing
CTA	Clinical Trial Application
CTAC	Clinical Trials Advisory Committee
DAIT	Division of Allergy, Immunology, and Transplantation
DC	Donor Center
DHHS	Department of Health and Human Services
DKMS	Deutsche Knochenmarkspenderdatei
DNA	Deoxyribonucleic Acid
DoD	Department of Defense
D/R	Donor/Recipient
DR	Disaster Recovery
DQ	Data Quality
DNA	Deoxyribonucleic Acid
DR	Disaster Recovery
D/R	Donor/Recipient
EBMT	European Group for Blood and Marrow Transplantation
EC	Ethics Committee
EFI	European Federation for Immunogenetics
ELISA	Enzyme-linked Immunosorbant Assay
EM	Expectation Maximization
EMDIS	European Marrow Donor Information System
ESRI	Environmental Systems Research Institute
FACS	Fluorescent Activated Cell Sorting
FILII	Filipino
FLOCK	Flow Cytometry Analysis Component
FY	Fiscal Year
GETS	Government Emergency Telecommunications Service
GCSF	Granulocyte-Colony Stimulating Factor (also known as filgrastim)
GIS	Geographic Information System
GM-CSF	Granulocyte Macrophage Colony Stimulating Factor

GVHD	Graft vs. Host Disease
GWAS	Genome Wide Association Studies
Gy	Gray-measure of dose of irradiation
HAWI	Hawaiian or other Pacific Islander Unspecified
HC	Hematopoietic Cell
HCT	Hematopoietic Cell Transplantation
HHQ	Health History Questionnaire
HHS	Health and Human Services
HIS	Hispanic
HIV	Human Immunodeficiency Virus
HLA	Human Leukocyte Antigen
HML	Histoimmunogenetics Mark-up Language
HR	High Resolution
HRSA	Health Resources and Services Administration
HSC	Hematopoietic Stem Cell
HSCT	Hematopoietic Stem Cell Transplant
IBMTR	International Bone Marrow Transplant Registry
IBWC	Immunobiology Working Committee
IDM	Infectious Disease Markers
Ig	Immunoglobulin
IHIWS	International Histocompatibility Work Shop
IHWG	International Histocompatibility Working Group
IIDB	Immunobiology Integration Database
IIMMS	International Immunomics Society
IMGT	ImMunoGeneTics
ImmPort	Immunology Database and Analysis Portal
IPD	Immuno Polymorphism Database
IPR	Immunobiology Project Results
IRB	Institutional Review Board
IS	Information Services
IT	Information Technology
JAPI	Japanese
KIR	Killer Immunoglobulin-like Receptor
KIR-DS	Killer Immunoglobulin-like Receptor Donor Selection
KORI	Korean
LD	Linkage Disequilibrium
LTA	Lymphotoxin Alpha
MALDI-TOF	Matrix-Assisted Laser Desorption/Ionization – Time Of Flight
MCW	Medical College of Wisconsin
MD	Medical Doctor
MDACC	MD Anderson Cancer Center
MDS	Myelodysplastic Syndrome

MENAFC	MidEast/North Coast of Africa
MHC	Major Histocompatibility Complex
MICA	MHC Class I-Like Molecule, Chain A
MICB	MHC Class I-Like Molecule, Chain B
mHAg	Minor Histocompatibility Antigen
MOU	Memorandum of Understanding
MRD	Minimal Residual Disease
MSKCC	Memorial Sloan-Kettering Cancer Center
MSWHIS	Mexican or Chicano
NAM	Native American
NAMER	North American
NCBI	National Center for Biotechnology Information
NCBM	National Conference of Black Mayors
NCHI	Chinese
NCI	National Cancer Institute
NECEP	New England Center for Emergency Preparedness
NHLBI	National Heart Lung and Blood Institute
NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
NIMA	Non-inherited maternal antigen
NK	Natural Killer
NL	Netherlands
NLM	National Library of Medicine
NMDP®	National Marrow Donor Program
NST	Non-myeloablative Allogeneic Stem Cell Transplantation
OCP	Operational Continuity Plan
ONR	Office of Naval Research
PA	Physician's Assistant
PBSC	Peripheral Blood Stem Cell
PCR	Polymerase Chain Reaction
PI	Principle Investigator
QC	Quality control
RadCCore	Radiation Countermeasures Center of Research Excellence
RCI	Resource for Clinical Investigations
RCI BMT	Resource for Clinical Investigations in Blood and Marrow Transplantation
RD Safe	Related Donor Safety
REAC/TS	Radiation Emergency Assistance Center/Training Site
REMM	Radiation Event Medical Management
RFP	Request for Proposal
RFQ	Request for Quotation
RITN	Radiation Injury Treatment Network
RT-PCR	Reverse Transcriptase-Polymerase Chain Reaction

SAA	Severe Aplastic Anemia
SBT	Sequence Based Typing
SCAHIS	South/Central American Hispanic
SCAMB	Black South or Central America
SCSEAI	Southeast Asian
SCT	Stem Cell Transplantation
SCTOD	Stem Cell Therapeutics Outcome Database
SG	Sample Group
SNP	Single Nucleotide Polymorphism
SOP	Standard Operating Procedure
SRG	Survey Research Group
SSO	Sequence Specific Oligonucleotides
SSP	Sequence Specific Primers
SSOP	Sequence Specific Oligonucleotide Probes
STAR®	Search, Tracking and Registry
TBI	Total Body Irradiation
TC	Transplant Center
TNC	Total Nucleated Cell
UCB	Umbilical Cord Blood
UCBT	Umbilical Cord Blood Transplant
UI	User Interface
UML	Unified Modeling Language
URD	Unrelated Donor
US	United States
USB	Universal Serial Bus
VP	Vice President
VIET	Vietnamese
WebEOC®	Web-based Emergency Operations Center
WGA	Whole Genome Amplification
WHO	World Health Organization
WHO-REMPAN	World Health Organization, Radiation Emergency Medical Preparedness and Assistance Network
WMDA	World Marrow Donor Association
WU	Work-up
XML	Extensible Markup Language
ZKRD	Zertrales Knochenmarkspender – Register für die Bundesrepublik Deutchland

Executive Summary

In 1986, Congress appropriated funds to begin development of the National Bone Marrow Donor Registry. Today, 26 years later, the National Marrow Donor Program (NMDP), as the contractor for the Registry, has built a racially diverse donor registry of more than 10.5 million donors, facilitated more than 50,000 hematopoietic stem cell transplants, developed comprehensive research programs to improve post-transplant outcomes, and established a network of transplant centers (TCs) capable of treating casualties resulting from military or terrorist actions, as well as patients suffering from leukemia, aplastic anemia, and other life-threatening diseases.

Contingency Preparedness Planning

As a result of grant support, the Radiation Injury Treatment Network® (RITN) grew in size and capability, and the visibility of RITN within the public health preparedness community was increased. New partnerships were solidified that will allow for development of future preparedness activities with regional, national, and international entities. RITN broke new ground in response to the Fukushima nuclear power plant emergency by providing situation reports to the network as well as our partners. These situation reports were a concise summary of many reports from organizations, governments, and open source news agencies, allowing readers to quickly review the status. RITN also coordinated multiple research, development and training opportunities for healthcare workers and the preparedness community.

Continued development of the NMDP's organizational resiliency program was refined and tested to show that our capabilities have improved, confirming that we are better prepared for a catastrophic operational interruption.

Rapid Identification of Matched Donors

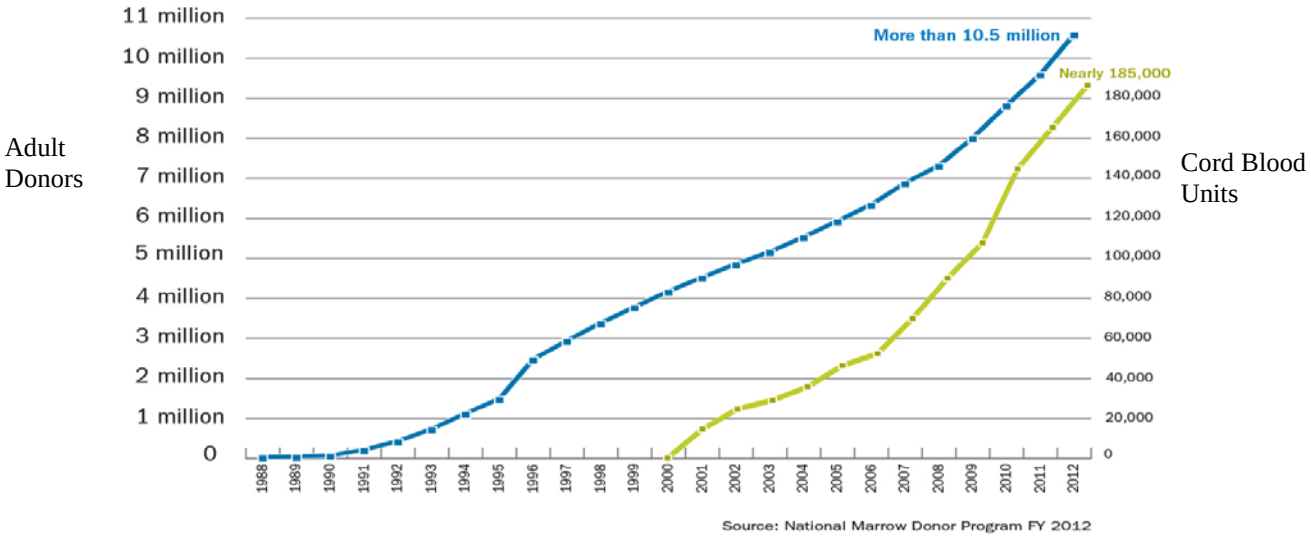
Published research data have clearly defined the relationship between HLA matching and optimal patient outcomes following unrelated adult donor transplantation. Continually working to increase the genetic diversity of the Registry helps to ensure that more patients will be able to locate a suitably matched stem cell product for a transplant**.**

During NMDP FY11, NMDP donor centers (including DoD) and recruitment groups recruited 259,612 minority race and 249,104 Caucasian donors, for a total of 508,716 U.S. donors added to the Registry. Navy funding contributed to the addition of 143,280 of this culturally diverse group of new donors, with 46,834 of these donors being minorities. All donors were typed for a minimum of HLA-A, B, and DRB1.

Advances in laboratory methods and technology continue to have a positive impact on lab performance and pricing. As of December, 2012:

- 97% of new donors received higher than intermediate HLA-A, B and DRB1 typing
- 52% of new donors received additional locus testing (HLA-C, DQB1 and DPB1)
- Blind quality control testing error rate was 0.08%, exceeding the project requirement of ≤ 2.0%.
- On-time testing completion rate was 99%, meeting the project requirement of a minimum of 90% of typing results reported within 14 days of shipment of samples.
- The cost of HLA typing continues to decrease as technology improves; in December 2012, the average price per sample was approximately $40.00 compared to $134.75 ($181.17 in 2012 dollars) in 1997, which represents a decrease of over 78%.

Be the Match Registry Growth: Adult Donors and Cord Blood Units



During this grant period, the NMDP completed the *7/8 High Resolution Donor Match Rate Study*. A previous Navy funded research project (FY10) estimated the 8/8 high resolution donor match rate for the four largest NMDP patient populations: Caucasian (CAU), African American (AFA), Hispanic (HIS), and Asian-Pacific Islander (API). This study used a simulated patient cohort of "pseudo-patients". As a second phase, a research project was developed and completed this period to estimate the 7/8 HLA high resolution donor match rate, given this is a typically acceptable match level for transplantation of an unrelated donor. The project also re-evaluated the 8/8 high resolution match rate which was previously determined using a 2009 donor registry snapshot. A total of 5130 donors and 6386 loci were typed during this project period. 9/10 and 10/10 match rates, which include HLA-DQB1, were also determined for all four race groups. Results (nearly complete) show disparity in 7/8 match levels between CAU (~98%) and non-CAU patients (~81-87%). The data relooking at the 8/8 match rate also showed improvement

from the 2009 dataset match rate of ~2-3% for each group. This represents new donor recruitment gains over the 3 year maturation of the NMDP registry.

During the grant period, NMDP completed development and implemented an enhanced version of the HapLogic matching algorithm that provided increased match precision, expanded HLA locus predictions and improved performance including:

- 3 locus matching → 5 locus matching
- x of 6 → x of 8, x of 10 predictions
- 5 broad race groups → 5 broad and 18 detailed race groups
- Ensuring visibility of NMDP's best matched donors and cords
- More precision for mismatch searches
- Better aligned with clinical practice
- Continued reduction in search run times
- Achieved median search run time of 35 seconds

Immunogenetic Research

The high resolution HLA typing of paired donor and recipient samples continued to provide substantive data to increase the understanding of the impact of HLA matching on patient outcome. The project data were also used to assess genetic diversity within the NMDP transplant population and Registry, and fed into the HapLogic matching algorithm. Testing was completed on an additional 110 donor/recipient and 295 CBU/recipient pairs during the project period, bringing the total enrolled to over 15,000. Typing at the HLA-DPB1 locus was added back to facilitate future studies of HLA-DPB1 matching. Presence/absence Killer Immunoglobulin-like Receptor (KIR) genotyping on 2DL1-5, 2DS1-5, 3DL1-3 and 3DS1 has continued. To date over 2400 pairs and 1180 additional donors have been typed for presence/absence of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1).

In order to continuously upgrade the Donor/Recipient Pairs Project, and include as many CBU/recipient pairs as possible, we have begun to include pairs with Whole Genome Amplification (WGA) DNA from the Repository. Samples of recipients and CBUs with limited blood or DNA samples in the research repository were selected and sent for WGA. WGA of these samples allowed for the inclusion of 295 CBU/recipient pairs during the grant period.

The high-resolution HLA data generated through the project are routinely incorporated into all outcomes analyses performed by the NMDP research program, the Center for International Blood and Marrow Transplant Research (CIBMTR), to provide the best HLA typing and matching information possible. The project has developed the largest, fully validated pool of unrelated stem cell transplant donor-recipient HLA data in the world and is an unparalleled resource for transplant research. The data generated through the project have had a major impact on the evolution of the NMDP HLA matching requirements.

Current HLA matching guidelines for unrelated Hematopoietic Cell Transplantation (HCT) recommend avoidance of mismatches only within the antigen recognition site, i.e., exons 2 and 3 for HLA class I and exon 2 for HLA class II. This recommendation is based on the hypothesis that amino acid differences outside the antigen recognition site are not immunogenic. The Antigen Recognition Site Allo-reactivity Assessment Project will give insight into the allowable tolerance of matching needed outside of this binding region. Preliminary results on DRB1*14:01 vs. *14:54 suggest that the mismatch may be less alloreactive than mismatches within the antigen binding domain.

Clinical Research in Transplantation

Prospective Research Activity
During this grant, the Resource for Clinical Investigations in Blood and Marrow Transplantation (RCI BMT), a division within CIBMTR, developed its infrastructure further and made progress on a number of studies. The goal of this program is to provide an avenue for investigators to obtain statistical, study and data management support for prospective trials focusing on addressing various transplant issues. The following key elements were accomplished:

- The Clinical Trials Advisory Committee (CTAC), whose mission is to provide scientific review and recommendations on clinical trial proposals, met a total of three times during this period.

- RCI BMT managed the Adult Double Cord Blood trial in patients with hematologic malignancies. During this grant period, accrual was met with a total of 56 patients enrolling. Staff continued to coordinate study activities, manage data and perform on site monitoring. A Tandem 2013 abstract was developed, submitted and accepted for oral presentation. A manuscript is submitted and under review.

- The Lenalidomide after allogeneic HCT for Myeloma trial met its accrual goal with 30 patients. Data management activities continued and a Tandem 2013 abstract was accepted for oral presentation.

- Staff supported the continued efforts related to the BMT CTN PBSC vs Marrow Phase III trial. This included managing the donor follow up component of the study and site monitoring at the donor centers. During this grant the Survey Research Group (SRG) acquired the five-year time point of the recipient quality of life and fully integrated this effort into their activities.

- The Long-Term Donor Follow-up protocol continued to accrue donors both from the previous donated group and prospectively as donors participated in the standard work-up process. At the end of this grant period close to 10,000 donors were enrolled.

- Study accrual and data submission in support of the CMS MDS study. Transplant Centers with a recipient enrolled on this study are required to submit the comprehensive research forms. A total of 82 recipient comprehensive report forms (CRF) were completed for this study during this period.

- RCI BMT staff worked with CIT staff to complete operational requirements for a comprehensive system for management of activities and studies within the SRG and clinical trial management system (CTMS) to coordinate operational and administrative activities within RCI BMT.

Support of the Observational Research program included statistical support for managing studies within the Immunobiology, GVHD, and Graft Sources Working Committees. During this grant period, staff performed proposal review, protocol development, data preparation, data analysis, and manuscript preparations. Details regarding the Immunobiology activities can be found in IID1.3 below. The GVHD and Graft Sources Working Committees published 9 manuscripts. During the grant period, staff supported progress on over 20 other studies.

Cord Blood Research Activity

During the project period, the Cord Blood Research sub-Committee met semi-monthly to discuss study priorities and plan analyses for the following:

- The Duke and MD Anderson laboratory staff completed work on validating the assay methodologies but were unable to ensure consistent results generated at both testing sites for the study investigating biomarkers associated with cord blood engraftment. Initial and final statistical analysis of the validation testing results showed poor inter-laboratory reliability for all assays performed. Therefore, testing using a third laboratory was developed with St. Louis Cord Blood Bank (SLCBB) to determine whether the poor reliability results from center-specific or assay-related issues.

- The Duke cord blood bank and St. Louis Cord Blood Bank (SLCBB) created and finalized plans and testing for training and validating the assay methodologies. The data analysis for the results of the training phase met the acceptable threshold for the inter-laboratory reliability coefficient of variation (CV); however, the validation phase data analysis did not. An investigation into the cause of the poor reliability is on-going and does not involve further testing of samples.

- A white paper detailing recommendations/guidelines for the assessment of new assays (potency or other assays) relevant to cord blood banking and/or transplantation was published in Cytotherapy. As a result, the NMDP was contacted by Hemogenix regarding a collaborative validation study for their potency assay (HALO).
- An analysis evaluating the likelihood of finding a non-inherited maternal antigen/allele (NIMA) match for HLA mismatched cord blood unit for transplant when upfront maternal typing is not available was completed. The retrospective analysis compared the frequencies of the NIMA matched and mismatched HLA- A, B antigens or DRB1 alleles found in the Eurocord/NMDP/CIBMTR study to determine any significant differences. Results were incorporated into a manuscript and submitted to and published in BBMT.
- Work began on a study to assess CBU characteristics (viability, TNC, CFU and CD34) pre-freeze and post thaw. Segment evaluation prior to unit release is under consideration as a third evaluation point, but will require an understanding of the release testing performed by the various CBBs. A survey was sent out to Network cord blood banks to collect data on cord blood release testing practices. The study design and proposal for submission to the CIBMTR was completed, submitted and accepted for presentation at the Graft Sources and Manipulation Working Committee at Tandem in 2013.
- Development of the anti-HLA donor specific antibody study of recipients transplanted with cord blood units was initiated. It was determined that the study cohort was too small to proceed with the study during the grant period.
- Work was initiated and completed on an assessment of the impact of donor inherited paternal antigen (IPA) disparity on outcomes after unrelated CBU transplantation for acute lymphoblastic leukemia and acute myelogenous leukemia. Results were detailed in an abstract submitted and accepted for poster presentation at the 2012 International Cord Blood Symposium.
- Two cord blood workshops were developed and conducted at both the 2011 and 2012 NMDP Council Meetings. Each workshop was well attended and received excellent ratings from the attendees.

CIBMTR IT Activity

- During the project period, significant strides were made in improving user experience, delivering new functionality, improving data quality, data capture and data reporting through the CIBMTR IT suite of applications.

Immunobiology Research Activity

To further stimulate completion of immunobiology studies within the CIBMTR, grant funds were used to provide support to investigators that required supplemental funding to cover

research sample access costs. One grant was awarded during the grant period. Grant funds also supported Immunobiology Working Committee (IBWC) leadership outreach activities to promote the activities and resources of the committee to the scientific community. The committee maintained a strong performance record with 6 abstracts, 10 publications (submitted or accepted) during the grant period. In addition, 6 new proposals were accepted by the IBWC during the BMT Tandem meetings in February 2012.

END – EXECUTIVE SUMMARY

II.A. Contingency Preparedness – Hypothesis 1:

Recovery of casualties with significant myelosuppression following radiation or chemical exposure will be optimal when care plans are designed and implemented by transplant physicians.

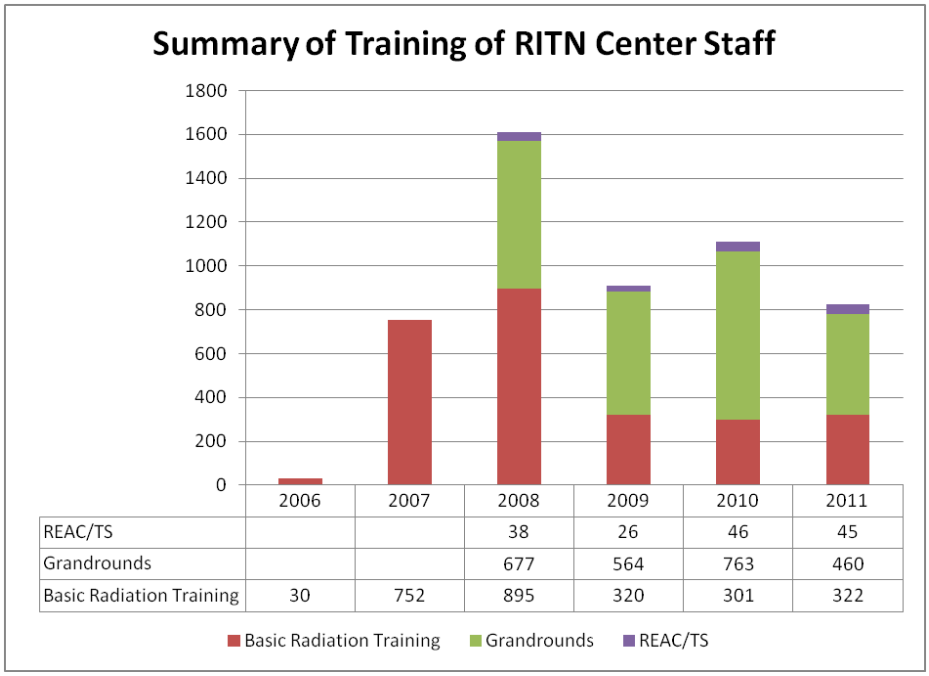
Aim A.1.1: Secure Interest of Transplant Physicians

This Aim was focused on the education of transplant physicians and their staff from Network centers affiliated with the Radiation Injury Treatment Network ® (RITN). RITN centers are required to complete educational tasks as part of their membership each year

RITN training efforts began with a short training course on Basic Radiation Training that was introduced in 2006. The course provided an hour of Continuing Medical Education credit to attendees and was quickly embraced by the transplant community. In 2008, a standardized medical grand rounds training course was developed for presentation at medical staff at RITN hospitals. In addition, RITN began to coordinate training of medical staff at the Radiation Emergency Assistance Center and Training Site (REAC/TS).

As depicted in Figure 1 below, 2,620 staff successfully completed the Basic Radiation Training course since 2006: 2,464 completed the Acute Radiation Syndrome Medical Grand Rounds and 155 partners completed the Advanced Radiological Medical Response at the Radiation Emergency Assistance Center and Training Site.

Figure 1: Table summarizing RITN training from 2006-2011



	2006	2007	2008	2009	2010	2011
REAC/TS			38	26	46	45
Grandrounds			677	564	763	460
Basic Radiation Training	30	752	895	320	301	322

Training conducted in Oak Ridge, Tennessee at the Radiation Emergency Assistance Center and Training Site is an intense two day Advanced Medical Training on Radiation Emergency Medicine course. Attendees earn 14 continuing medical education credits for attending this rigorous course which covers a comprehensive set of topics including:

- Basic Health Physics & Radiation Protection: Part I
- A History of Serious Radiological Incidents: The Real Risk
- Health Physics & Contamination Control: Part II
- Radiation Detection, Monitoring & Protection Laboratory Exercise & Quiz
- Diagnosis & Management of the Acute Radiation Syndrome
- Diagnosis & Management of Internal Contamination
- Diagnosis & Management of Acute Local Radiation Injury & Case Review
- Radiation Sources & Radiological Terrorism
- Radiation Emergency Area Protocol Demonstration
- Radiation Emergency Medical Management Drill
- Radiation Dose Estimations – Problem Solving Session

One limitation to the available RITN courses has been the method of delivery. With this in mind, a web based learning management system was procured to allow development and deployment of web based training. The web based system will allow more people to complete the training provided and allow for instantaneous test grading with on demand printing of certificates of completion. To present a consistent image and develop professional training materials, an Instructional Designer was hired to formulate a theme and organize the approach to the web based training materials. The approach that was developed is to have multiple training modules that are all independent, yet when taken as a group, can be used to orient new members of the RITN. Modules that were completed and released through this grant include:

1. Introduction to the Radiation Injury Treatment Network
2. Basic Radiation Training
3. Government Emergency Telecommunications Service Calling Card Usage
4. Satellite Telephone Training for the Radiation Injury Treatment Network

Additional courses that will be completed under a subsequent grant include:

5. Radiation Injury Treatment Network Concept of Operations Training
6. Basic Radiation Training for Non-medical Staff

Figure 2. Screenshots of the new RITN Training Materials

Aim A.1.2: GCSF in Radiation Exposure

This Aim focused on non-transplant treatment guidelines and patient assessment related to the use of granulocyte colony stimulating factor (GCSF) for patient treatment as a result of a marrow toxic mass casualty incident such as exposure to ionizing radiation.

2011 RITN State of the Science Workshop: Radiation Exposure, Medical Countermeasures and Treatment

In support of the development of non-transplant treatment protocols (Aim A.1.2), transplant treatment protocols (Aim A.1.3), physician education (Aim A.1.1) and the RITN (Aim A.2.1), a conference was held on October 11, 2011 in Chicago, IL. The RITN *State of the Science Workshop: Radiation Exposure, Medical Countermeasures and Treatment* was attended by 125 physicians, medical staff, researchers, public health officials, and emergency planners.

The purpose of the conference was to highlight the following:

Response to a radiological mass casualty incident which would stress the capacity of the entire U.S. medical community. Through optimization of care and thoughtful planning, some of the resource gaps can be closed and resiliency improved. Presentations provided updates on research in the biology of radiation exposure, biodosimetry, supportive care, immune reconstitution, and medical countermeasures.

With the following educational objectives:

1. Describe developments in the research of biological effects of exposure to ionizing radiation.
2. Explain currently available and research methods for measuring the dose of radiation absorbed by victims.

3. Outline organ system and systemic responses to ionizing radiation exposure.
4. Describe the impact of the Japanese Nuclear Power Plant incident on clinical and research infrastructure.
5. Discuss the path to preparedness for a mass casualty incident with injuries due to the exposure to ionizing radiation.

The agenda presented a balance between unpublished updates on current research to operational strategies to respond to the detonation of an improvised nuclear device:

1. "Where We Are and Where We Are Going"-Richard Hatchett (DHHS-BARDA)
2. Biodosimetry:
    a. High-Throughput Minimally-Invasive Radiation Biodosimetry - Sally Amundson (Columbia)
    b. Informing Biosignatures with Data from Model Systems - Joseph Lucas (Duke)
    c. Physical Biodosimetry for Triage After a Large Scale Radiation Event - Harold Swartz (Dartmouth)
3. Supportive Care: Medical Countermeasures for the ARS: Evidence Based Support and the FDA Animal Rule - Tom MacVittie (Univ. Maryland)
4. Hematopoietic and Immune System Reconstitution:
    d. Combined Radiation Injury - Nelson Chao (Duke)
    e. Stem Cell-Based Therapies for Acute Radiation Syndrome - Chandan Guha (Albert Einstein College of Medicine)
    f. Novel Mitigators of the Hematopoietic Syndrome - John Chute (Duke)
    g. Strategies to Enhance Immune Reconstitution Post Irradiation - Marcel van den Brink (Memorial Sloan Kettering Cancer Center)
5. Organ Toxicity:
    h. Pulmonary Toxicity - Zeljko Vujaskovic (Duke)
    i. Gastrointestinal Organ Toxicity - Martin Hauer Jensen (Univ. of Arkansas for Medical Sciences)
6. Radiation Biology:
    j. Design of Mitochondria-Targeted Radio Protectors/Mitigators - Valerian Kagan (Univ. Pittsburgh)
    k. The Role of P53 in Acute Radiation Injury and Late Effects from Radiation - David Kirsch (Duke)
7. Guided Discussion: Autologous Cell Collection for Radiological Disaster Responders - David Weinstock (Dana Farber Cancer Institute)

8. Global Consensus on Evidence-Based Management of Acute Radiation Syndrome - Nickolas Dainiak (Yale) and Viktor Meineke (Bundeswehr-Germany Military)
9. Keynote: Experience in Japan During the Fukushima Incident - Robert Bazell (NBC News)

Overall feedback from attendees was excellent. Sessions and speakers were highly rated in conference evaluations, scoring 4.67 out of a possible of 5.0. All evaluators reported learning something new during the conference and 85% of the evaluators indicated that they will directly apply information learned in their practice.

Post-Conference Review of Logistical Issues During Incident Response

The day following the conference, a closed meeting was held to review three key concepts related to a radiological incident:

1. Define when a victim crosses the threshold from solely requiring intensive supportive care to requiring HCT.
2. Determine best practices used to expand available care when confronted with mass casualties with marrow toxic injuries.
3. Determine what level of additional review is necessary to gather agreement for each area.

The outcomes of these discussions were incorporated in an update to the RITN Acute Radiation Syndrome Treatment Guidelines described in Aim 1.3 below.

Aim A.1.3: Patient Assessment Guidelines

This Aim focused on the development of transplant treatment guidelines and the associated support systems, including the refinement of guidelines for patient assessment and the operational and educational aspects of rapid product selection and transplant as necessary in a marrow toxic mass casualty event such as radiation exposure.

Activity under this aim was incorporated into the RITN educational conference for medical staff, researchers, and public health officials entitled *State of the Science Workshop: Radiation Exposure, Medical Countermeasures and Treatment* that was described in detail under Aim A.1.2 section.

Aim A.1.3: Patient Assessment Guidelines and System Enhancements

Review of Logistical Issues During Incident Response

A one day meeting was held in conjunction with the State of the Science Workshop to discuss updates to the RITN Acute Radiation Syndrome Treatment Guidelines. The following key results were solidified and used to update the guidelines:

1. **Which products (bone marrow, peripheral blood stem cells, and umbilical cord blood) would be preferred for a radiological casualty?**
   a. *Bone marrow will likely be the preferred option as GCSF will be in limited supply as most available stock is redirected to the Strategic National Stockpile (SNS). GCSF in the SNS is currently limited to 5,000 doses although there is additional likely to be available through vendor-managed inventory.*
   b. *Cord blood units will be an alternative.*
   c. *This could raise issues for patient treatment that requires growth factors.*
2. **What are the appropriate preparative regimens for transplantation?**
   a. *The existing RITN treatment guidelines, based on a standard regimen for patients with aplitic anemia, remains a reasonable option*
   b. *Guidelines for growth factors and other supportive care after transplantation are not included*
3. **Can a center handle 30 HCT in a 2 week period?**
   a. *Assuming that only ~10% of the 300 patients at each center require transplant and the rest only require observation and supportive care.*
   b. *Need to determine what the limited resources would be for 30 HCTs.*
   c. *S3 or G3 will not be a HCT candidate until condition improves and are stabilized (S3 refers to significant cutaneous acute radiation syndrome and G3 refers to significant gastrointestinal ARS per the "Fleidner Protocol").*
4. **What are the minimum logistical requirements for medical care of radiation exposure patients?**
   a. Expected recovery with observation and modest support
      i) Equivalent to H1 diagnosis (Degree 1 in table below)
   b. Probable recovery with intermediate support
      i) Equivalent to H2 diagnosis(Degree 2 in table below)
   c. Possible recovery with intensive support including transplantation of HPC
      i) Equivalent to H3/H4 diagnosis(Degree 3 & 4 in table below)

Table 1. Acute Radiation Syndrome Severity Rating by Laboratory Tests for the Hematopoietic Subsyndrome

HEMATOPOIETIC SUBSYNDROME [1]				
Sign/Symptom/Test	**Degree 1**	**Degree 2**	**Degree 3**	**Degree 4**
24 - 48 HOURS Serial CBCs recommended to improve estimation of severity. (Lymphocyte kinetics and dose, How frequent?)				
Lymphocyte count (10^9 cells/L)	≥ 1.5	1.5 - 1	1 - 0.5	< 0.5
Granulocyte count (10^9 cells/L)	> 2	4 - 6, mild granulocytosis	6 - 10, moderate granulocytosis	> 10, marked granulocytosis
Platelet count (10^9 cells/L)	≥ 100	100 - 50	100 - 50	100 - 50
3 - 7 DAYS Serial CBCs recommended to improve estimation of severity. (Lymphocyte kinetics and dose, How frequent?)				
Lymphocyte count (10^9 cells/L)	≥ 1	1 - 0.5	0.5 - 0.1	< 0.1
Granulocyte count (10^9 cells/L)	> 2	> 2	> 5 (note the high granulocyte with low platelets is a poor prognostic sign)	> 5
Platelet count (10^9 cells/L)	≥ 100	100 - 50	50 - 20	< 20

1. Modified from the NIH REMM draft ARS treatment website, which created the original by modifying from Fliedner, TM, Friesecke, I, Beyrer K. Medical Management of Radiation Accidents: Manual on the Acute Radiation Syndrome. Oxford: British Institute of Radiology; 2001.

5. **What is the expected availability of REAC/TS staff to answer questions from RITN centers on internal contamination, etc…?**
   a. *REAC/TS will be have staff at office in TN as well as one or two teams with the Federal Radiological Monitoring and Assessment Center (FRMAC).*
   b. *REAC/TS staff will be accessible to answer treatment questions at a minimum via email.*
   c. *Staff in TN will be able to ship decorporation agents.*
6. **What are the criteria for determining which patients are appropriate candidates for HLA typing, donor recruitment and transplantation?** With the intent that 1) resources not be wasted on candidates who are not appropriate and 2) that the transplantation process be expedited for those who are appropriate candidates.
   a) Typing- Perform HLA typing if expected to survive other injuries AND one or more of the following:
      a. Perform HLA typing if whole body dose equivalent to >3 Gy
      b. Neutrophil <100, beyond 7 days from exposure
      c. Rapid drop in platelet, consistent with H3 or H4
   b) Recruitment- Recruit donor if expected to survive other injuries AND ALL of the following:
      a. Bone marrow is aplastic at two locations (Day 14-D21 after exposure)
      b. Neutrophil sill <100 after 5 days of cytokines
      c. Suitable donor:
         i. 8/8 match (HLA-A, B, C, DRB1) for bone marrow or PBSCs
         ii. 4/6 match for cord blood

iii. Haploidentical or mismatched T-cell depleted transplant would be an alternative is available

c) Infusing Cells – Infuse cells if expected to survive other injuries AND ALL of the following:

a. Aplastic bone marrow
b. ANC <100
c. Beyond Day 21 after exposure and received 7-10 days of GCSF

NMDP systems were enhanced during the period of performance. Additional data storage capacity was procured to allow:

- Synchronization of critical data for Donors and Cords
- Continued support for the disaster recovery information technology environment

These enhancements will reduce the time to resume critical operations and ensure limited to no interruptions in access to search and procurement services.

Aim A.1.4: National Data Collection Model

No funding was requested under this Aim for the 0339 budget cycle.

II.A. Contingency Preparedness – Hypothesis 2:

Coordination of the care of casualties who will require hematopoietic support will be essential in a contingency situation.

Aim A.2.1: Contingency Response Network

This Aim focuses on the activities of the RITN. The RITN was organized to provide comprehensive evaluation and treatment for victims of radiation exposure or other marrow toxic injuries. The RITN develops treatment guidelines, educates health care professionals, works to expand the network, and coordinates situation response. The RITN is a cooperative effort of the NMDP and The American Society for Blood and Marrow Transplantation (ASBMT).

During this period of performance, the RITN grew to include 60 centers comprised of:

- 47 transplant centers
- 6 donor centers
- 7 cord blood banks

The RITN provides comprehensive evaluation and treatment for victims of radiation exposure or other marrow toxic injuries.

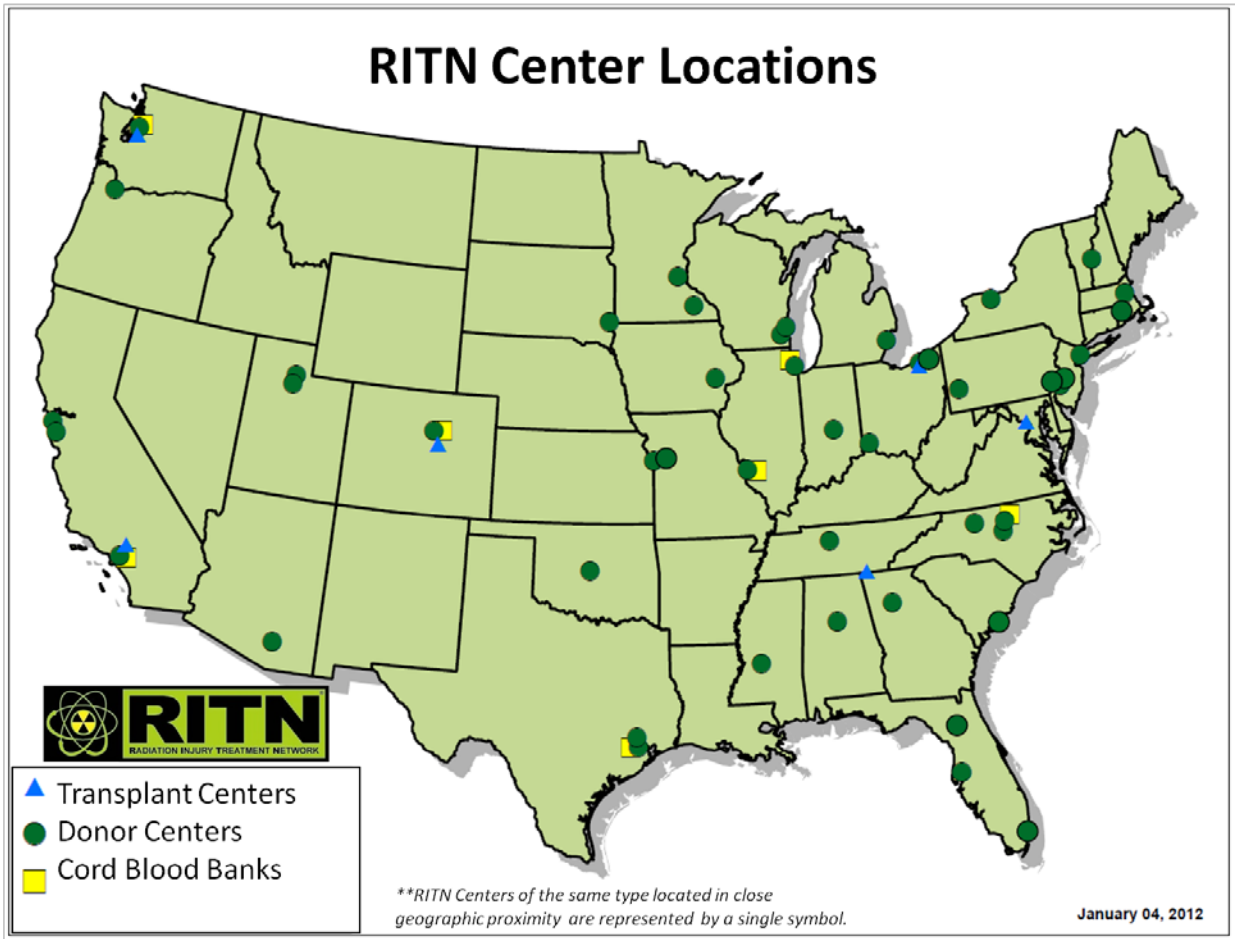
Many of the casualties with radiation injury will be salvageable but require outpatient and/or inpatient care. Recognizing this, the NMDP, US Navy, and American Society of Blood and Marrow Transplantation (ASBMT) collaboratively developed RITN, which is comprised of medical centers with expertise in the management of bone marrow failure, stem cell donor centers, and umbilical cord blood banks across the US.

The goals of RITN are:

1. To develop treatment guidelines for managing hematologic toxicity among victims of radiation exposure,
2. To educate health care professionals about pertinent aspects of radiation exposure management,
3. To help coordinate the medical response to radiation events, and
4. To provide comprehensive evaluation and treatment for victims at participating centers.

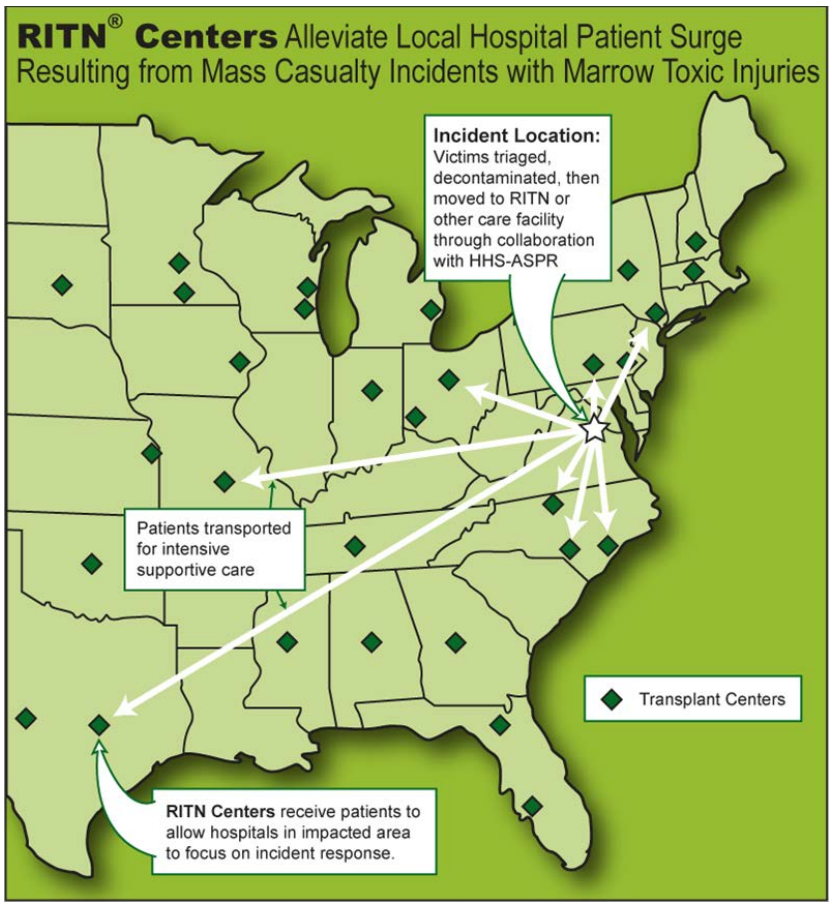
These centers are spread across the nation as shown in the Figure 3 below.

Figure 3. RITN Center Locations in the United States



RITN centers are prepared to receive casualties from a mass casualty incident with marrow toxic injuries; however, it is important to understand that RITN centers are not first responders. All participating centers voluntarily prepare to respond to an incident that occurs in another city or some other distant location. The NMDP anticipates that the RITN will receive patients from another part of the country to alleviate their medical load and to provide the best care possible (see figure below for overview of casualty flow).

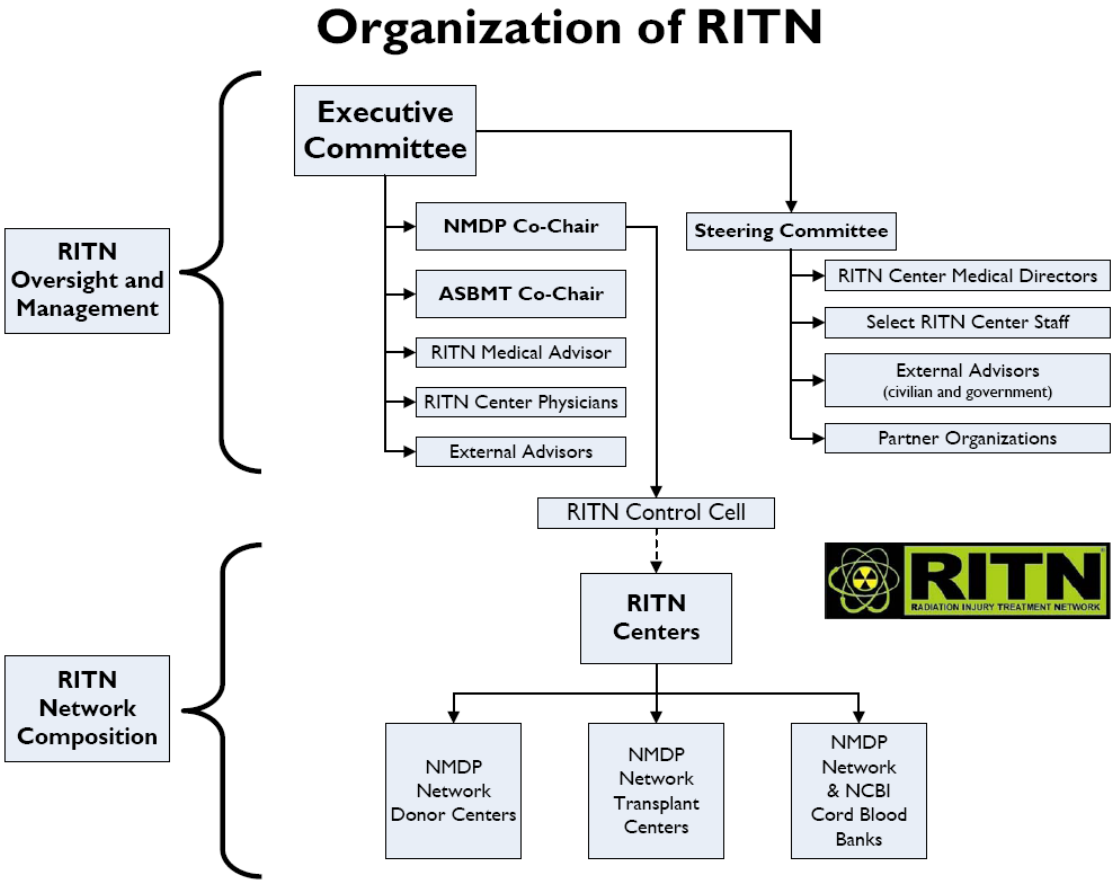
Figure 4. Overview of RITN Casualty Flow



The RITN is managed by an Executive Committee which develops or reviews all RITN materials from the training courses to the treatment guidelines. As part of the Executive Committee, the RITN Control Cell interfaces with the network of medical professionals that RITN is comprised of. Supporting the Executive Committee is a Steering Committee consisting of RITN center staff, federal advisors, and partners.

The Executive Committee meets every other month via teleconference and the Steering Committee meets once a year during the annual ASBMT/CIBMTR Tandem BMT Meetings. Since many members of RITN already regularly attend this annual conference, there is a cost savings to hold the Steering Committee meeting at the conference as well as broadcasting the strong relationship between the RITN and ASBMT.

Figure 5. Organization of RITN



The **RITN Executive Committee** is co-chaired by a representative from the NMDP and from the ASBMT, and assisted by a Medical Advisor, other physicians, and technical advisors that support the activities of this committee:

- Committee Chairs:
  - Co-Chair: Dennis Confer, MD
  - Co-Chair: Nelson Chao, MD (ASBMT past President)
- RITN Medical Advisor:
  - David Weinstock, MD
- Committee Members:
  - Transplant Physician: Daniel Weisdorf, MD (ASBMT past President)
  - Transplant Physician: John Chute, MD
  - ASBMT Representative: Julie Wilhauk, ARNP, AOCNP
  - ASBMT Representative: Robert Krawisz, MBA
  - RITN Program Manager: Cullen Case Jr., CEM

Some of the outcomes of Executive Committee conference calls held during this period of performance include:

- Identification of possible bone marrow transplant programs to be invited to join RITN in the future
- Development of the agenda, content, and speakers for the 2011 RITN Educational Conference "State of the Science Workshop: Radiation Exposure, Medical Countermeasures and Treatment"
- Development of agendas for Steering Committee meetings and coordination of presentations by external subject matter experts at the Steering Committee meetings

A key partnership was initiated with the American Hospital Association (AHA), National Association of City and County Health Officials (NACCHO), and the Association of State and Territorial Health Officials (ASTHO).

During the period of performance, the **Steering Committee** held three in person meetings:

- February 2011 - ASBMT/CIBMTR Tandem Meetings (Honolulu, HI)
- October 2011 – 2011 RITN Educational Conference (Chicago, IL)
- February 2012 - ASBMT/CIBMTR Tandem Meetings (San Diego, CA)

Monthly, all RITN center staff, as well as RITN partners, are invited to a conference call where updates are provided on current projects, RITN center staff are afforded an opportunity to talk about implementation issues with other more seasoned RITN centers, and the "Rad in the News" is reviewed. "Rad in the News" is a summary of highlights with links to open source media reports about radiological related current events. In addition to these monthly meetings, each December, a RITN Year in Review webinar was held which reviews the accomplishments during the year and planned activity in the upcoming year.

RITN Annual Tasks

RITN centers are tasked each year with completing a set of tasks in exchange for a small grant. During this period of performance, centers had to update their standard operating procedures, conduct a tabletop exercise, and conduct training of staff.

Table 2. Summary of Tasks for RITN Centers by type

TASK SUMMARY TABLE:

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Grant
	Contact	SOP	Tabletop	Commo.	Overview	Educate	Site Eval.	
TC	Yes	Yes	Yes	Yes	Yes	6 or 7	6 or 7	$8,000
DC	Yes	Yes	No	Yes	5 or 6	5 or 6	No	$2,000
CBB	Yes	Yes	No	Yes	5 or 6	5 or 6	No	$2,000

Annual RITN Tabletop Exercise (TTX)

Each year, one of the tasks is to conduct a tabletop exercise with hospital staff and local public health preparedness officials. During this period of performance, the scenario for the tabletop exercise focused on the flow of casualties through the National Disaster Medical System in response to the detonation of a 10kT improvised nuclear device:

> *A mass casualty incident that results in marrow toxic injuries most likely would result from a terrorist detonation of an improvised nuclear device or a catastrophic industrial accident. The Department of Homeland Security's National Planning Scenarios include 16 possible terrorist incidents that would significantly impact the United States. Each scenario describes the scope of the incident and offers estimates of the number of resulting casualties. One of these scenarios is the detonation of a 10 kT (kiloton) improvised nuclear device, which is approximately equivalent to the bomb detonated over Hiroshima during World War II.*

Each RITN center was asked at the conclusion of the exercise how they would respond to a request to potentially accept up to 200 casualties. The results of each year's tabletop exercise, including each centers response to all of the questions, are posted (in a non-attributable format) on the RITN website: .RITN.net/exercises/. Some highlights of responses from this year's exercise are included below.

Figure 6. Selected Responses from RITN Tabletop Exercise Questions

Figure 6a.

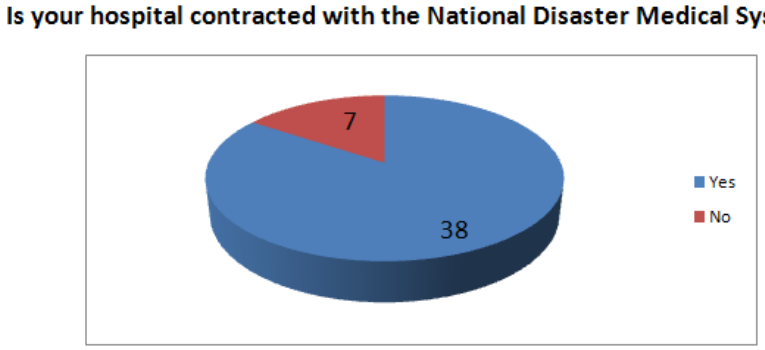


Figure 6b.

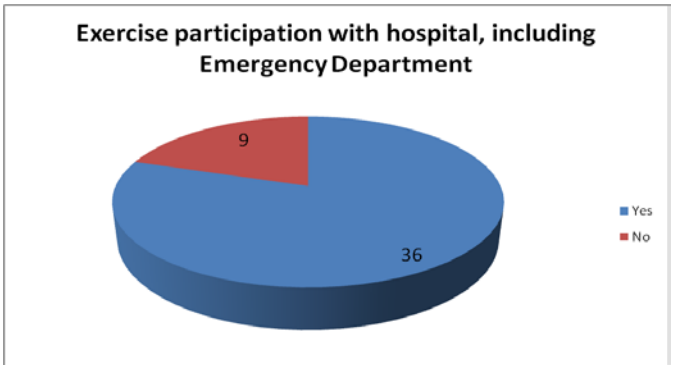


Figure 6c.

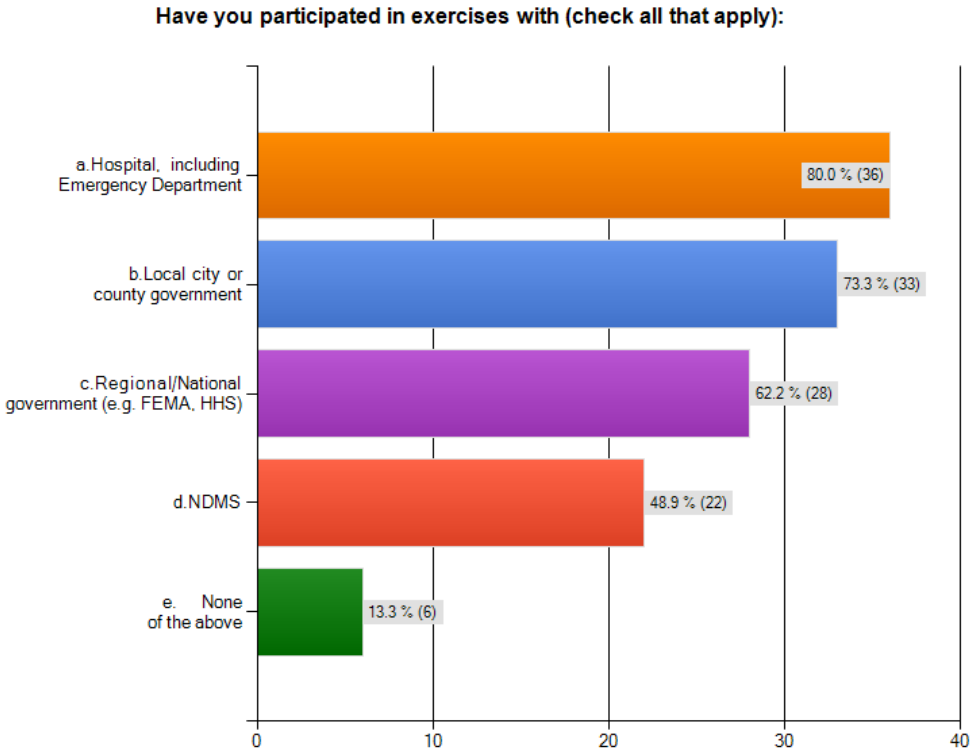


Figure 6d.

Are there particular medications (e.g. antibiotics), supplies (e.g. IV tubing, blood products), or equipment (e.g. beds, IV pumps) that you anticipate would be in short supply at your center and therefore limit your ability to care for a large number of irradiated casualties?

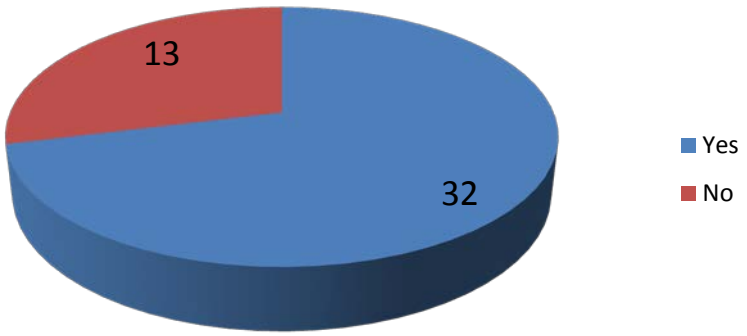


Figure 6e.

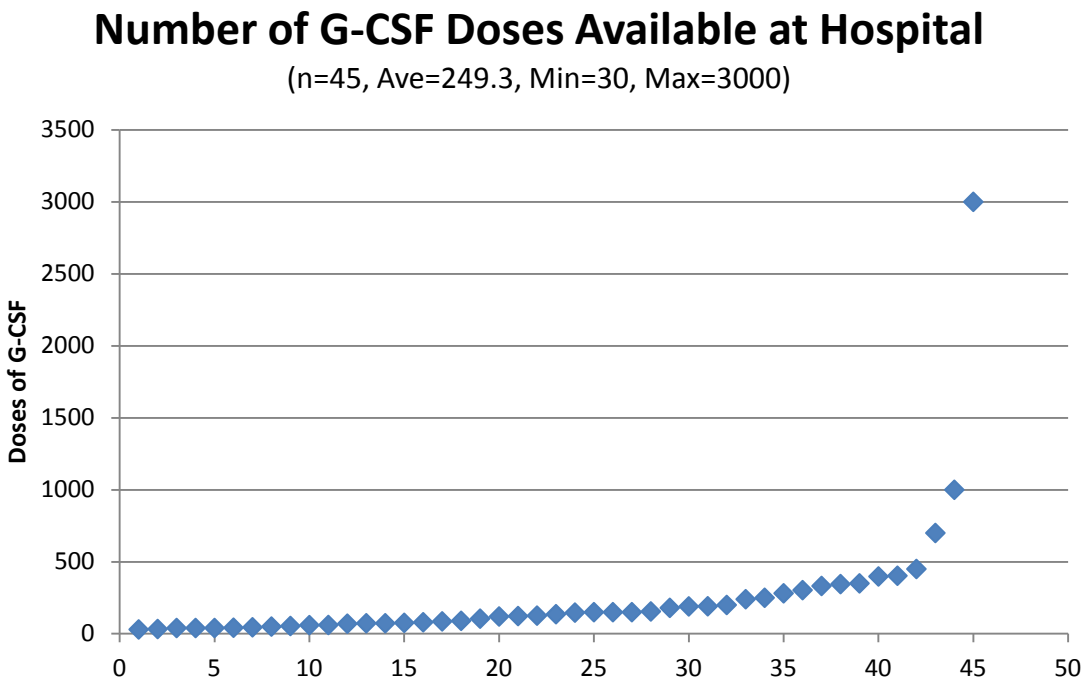


Figure 6f.

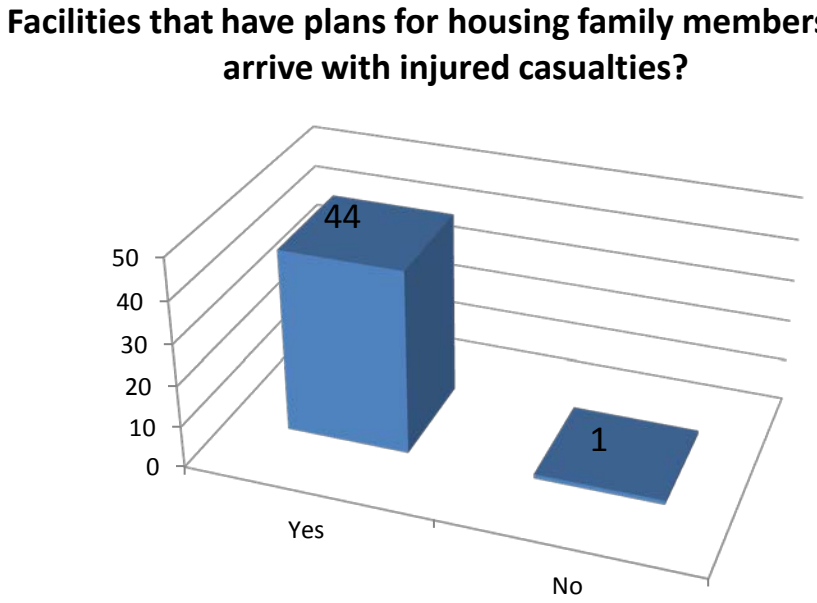
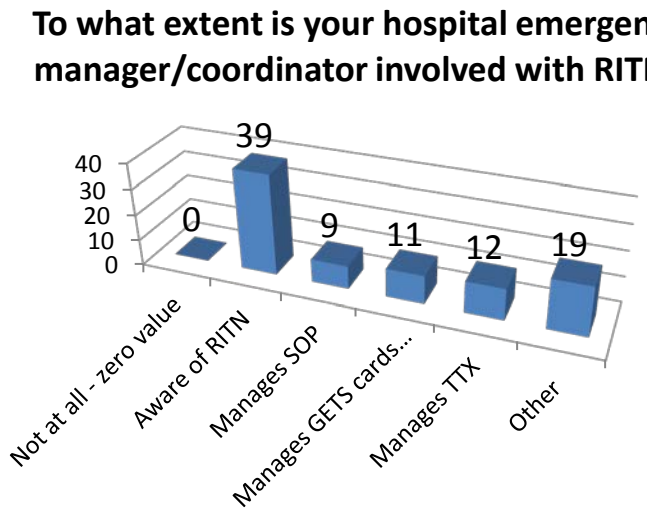


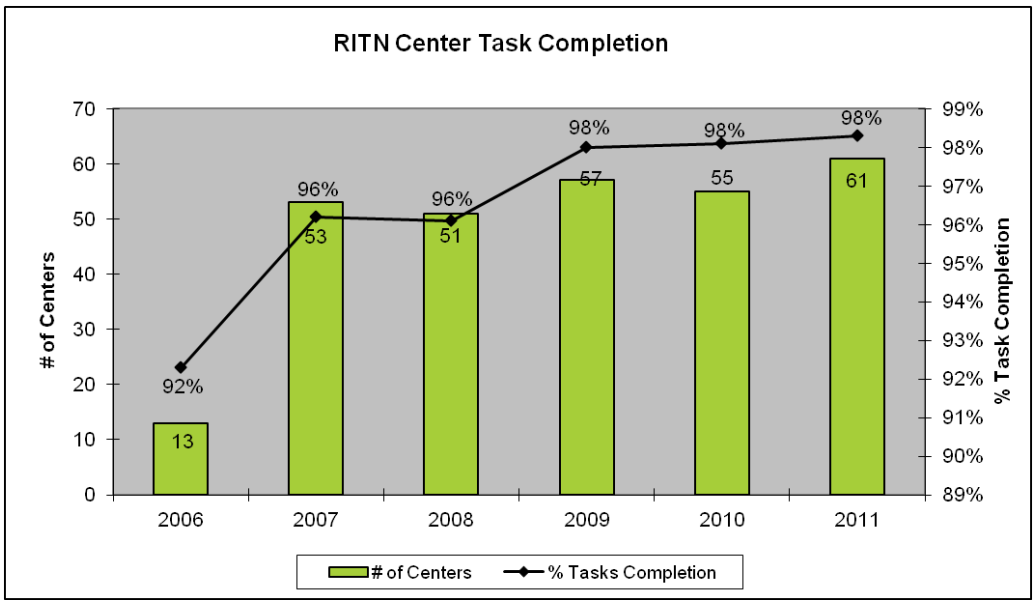
Figure 6g.



Annual Task Completion

During this grant period, 98% of the RITN centers completed all of their tasks (Figure 7), a slight improvement over the previous grant period.

Figure 7. RITN Center Task Completion



RITN Partnerships

The RITN would not be able to successfully respond to a mass casualty incident without the support of partner organizations. The NMDP has carefully worked to develop and maintain these relationships so that when an event occurs, established relationships are already in place with these key response organizations.

RITN has two types of relationships; formal relationships are documented through a Memorandum of Understanding (MOU) and informal relationships through periodic collaboration.

RITN has established formal partnerships through an MOU with:

- Office of the Assistant Secretary for Preparedness and Response, Department of Health and Human Services (ASPR-DHHS)
- American Society for Blood and Marrow Transplantation (ASBMT)
- American Association of Blood Banks (AABB), through the AABB Inter-organizational Task Force for Disasters and Acts of Terrorism
- New England Center for Emergency Preparedness (NECEP)

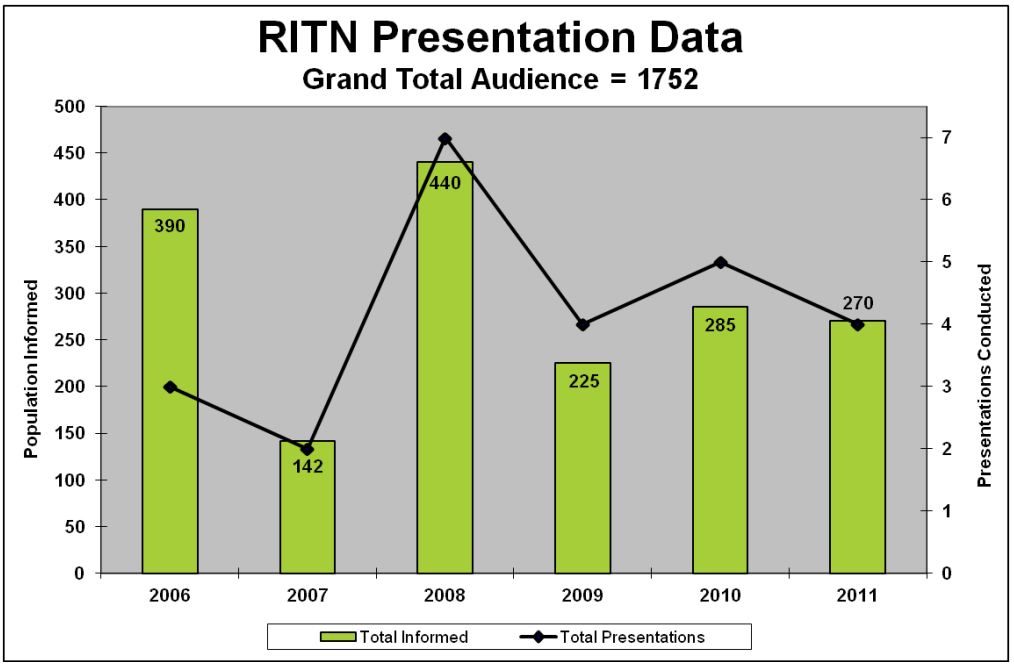
Organizations that RITN has developed informal relationships with include:

- Radiation Countermeasures Centers of Research Excellence (RadCCORE) at Duke University
- The National Institutes of Health, The National Institute of Allergy and Infectious Diseases, Division of Allergy, Immunology and Transplantation (NIH-NAIAD-DAIT)
- Radiation Emergency Medical Management web portal (NIH-NLM-REMM)
- National Cancer Institute's (NCI)
- Biomedical Advanced Research and Development Authority (BARDA)
- European Group for Blood and Marrow Transplantation (EBMT) - Nuclear Accident Committee
- The Radiation Emergency Medical Preparedness and Assistance Network of the World Health Organization (WHO-REMPAN)
- Radiation Emergency Assistance Center and Training Site (REAC/TS)
- American Hospital Association (AHA)
- American Medical Association (AMA)
- National Association of City and County Health Officials (NACCHO)
- Association of State and Territorial Health Officials (ASTHO)

Education and Awareness Training about RITN

To increase the visibility of RITN and make new connections with additional organizations and agencies, overview presentations were given to various professional groups and government agencies. The chart below summarizes the number of these presentations given, as well as the size of the audience affected:

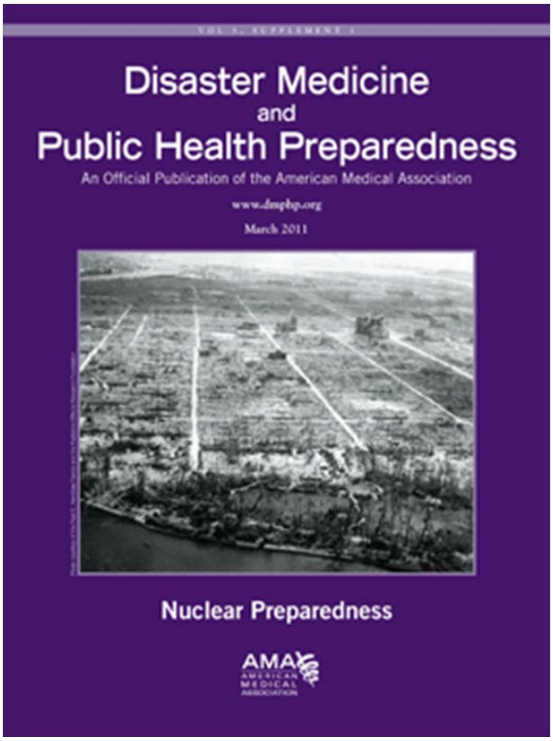
Figure 8. RITN Presentation Data



Publications

Another avenue of increasing visibility is through publication in peer reviewed journals. The Executive Committee was involved with many publications during this period of performance; however, the most visible and impactful to the preparedness of the nation is the "Disaster Medicine and Public Health Preparedness Nuclear Preparedness" journal in which the RITN Medical Advisor co-authored 8 of the 17 articles (the journal is open source and available online: ://www.dmphp.org/content/vol5/Supplement_1/)

Figure 9. RITN Publication from March 2011



Additional publications include:

- N Dainiak, RN Gent, Z Carr, et al. Literature Review and Global Consensus on Management of Acute Radiation Syndrome Affecting Non-Hematopoietic Organ Systems, Disaster Medicine and Public Health Preparedness, October 2011
- N Dainiak, RN Gent, Z Carr, et al. First Global Consensus for Evidence-Based Management of the Hematopoietic Syndrome Resulting from Exposure to Ionizing Radiation, Disaster Medicine and Public Health Preparedness, October 2011
- Weisdorf D, Weinstock D, Case C, Chao N, Confer DL. Planning and response to radiation exposures. Biol Blood Marrow Transplant. 2011 Aug;17(8):1262-3. Epub 2011 Jun 15.
- Joel Ross, Cullen Case, Nelson Chao, et al. Radiation Injury Treatment Network (RITN): Healthcare professionals preparing for a mass casualty radiological or nuclear incident. Int. J. Radiat. Biol., Vol. 87, No. 5, PrePub Feb 2011

For the 104 days following the disaster at the Japanese Nuclear Power Plant in Fukushima, daily summary situational awareness reports were sent to RITN centers and RITN partner organizations. Requests from the AHA to the CDC were made to receive copies of these reports, increasing the number of RITN partners and RITN's visibility in the preparedness community.

Many radiological or nuclear disaster articles were written that highlighted the incident in Japan. The following articles referenced RITN or quoted RITN Executive Committee members or staff from RITN centers:

1. 4/15/2011 - Should Japan Bank Stem Cells From Fukushima Nuclear Workers? Science, Accessed 4/18/2011, ://news.sciencemag.org/scienceinsider/2011/04/should-japan-bank-stem-cells.html?ref= (Weinstock-RITN Med. Advisor, Chao-RITN Exec. Cmte)
2. 4/10/2011 - Transplants for Thousands, New York Times, Accessed 4/15/2011, ://www.nytimes.com/2011/04/11/opinion/lweb11marrow. (Chell-NMDP CEO)
    a. In response to the 4/1/2011 article New Urgency in Push for Radiation Drugs ://www.nytimes.com/2011/04/01/business/01radiation.html?_r=
3. 3/29/2011 - Amid Japan crisis, hunt for better radiation care, Associated Press, Accessed 4/18/2011, ://www.google.com/hostednews/ap/article/ALeqM5gWg0vQLaVibv2GDZ9Hs5JVYQ91ug?docId= (Chao-RITN Exec. Cmte)
4. 3/17/2011 - As Radiation Drifts Toward U.S., Officials Downplay Risk, San Gabriel Valley Tribune, Accessed 3/18/2011, ://www.sgvtribune.com/news/ci_17638624?IADID=Search-www.sgvtribune.com-www.sgvtribune. (Chuck Pickering-COH, LA)
5. 3/17/2011 - Little Protection for Those on the Front Lines, Science, Accessed 3/18/2011, ://news.sciencemag.org/scienceinsider/2011/03/little-protection-for-those-on-t.html?ref= (Weinstock-RITN Med. Advisor, Chao-RITN Exec. Cmte)
6. 3/15/2011 - Experts plan for how to deal with nuclear terror strike, USA Today, Accessed 3/17/2011, ://www.usatoday.com/news/nation/2011-03-15-nukemed14_ST_N.htm?loc= (Weinstock-RITN Med. Advisor)

Aim A.2.2: Develop and test standard operating procedures, in conjunction with core transplant centers, to manage the activities required to HLA type siblings of casualties to evaluate their potential as HSC donors for their affected family member.

No funding was requested under this Aim for the 0339 budget cycle.

II.A. Contingency Preparedness – Hypothesis 3:

NMDP's critical information technology infrastructure must remain operational during contingency situations that directly affect the Coordinating Center.

Aim A.3.1: Disaster Recovery: Ensure NMDP's ability to access and utilize its information management and communication infrastructure in a contingency situation in which its Minneapolis Coordinating Center is damaged or destroyed.

No activity was requested under this Aim for the 0339 Budget Cycle

Aim A.3.2: Operational Continuity Planning:

The focus of this Aim is to improve organizational resiliency to severe operational disruptions through Operational Continuity Planning. In the event that the Coordinating Center is not available for an extended period of time, critical tasks will have to be conducted at an alternate location. To meet these needs, the NMDP maintains an Operational Continuity Plan (OCP), consisting of documented procedures for guiding the organization to respond, recover, resume and restore a predefined level of operations following disruptions, including a Critical Task List to prioritize the response.

The OCP is annually reviewed by key stakeholders to test planned response actions with current business practices and predefined maximum tolerable periods of disruption (MTPD). MTPD is the time it takes for adverse impacts as a result of not providing services or performing activity to become unacceptable. Inputs for the OCP improvement include current operations impact analyses, functional and tabletop exercises, and industry regulatory or standard changes. The OCP is adaptable and enables the organization to respond to a wide range of disruptive incidents, including those the NMDP may not have anticipated. The NMDP's formal OCP is maintained by the Operational Continuity Planner.

During this period of performance the NMDP conducted several significant exercises. A tabletop exercise with the Operational Continuity Planner and the IT Disaster Recovery staff (OC/DR) focused on a step-by-step review of incident response flow for the following contingency incident scenarios:

- Coordinating Center unavailable, data center available
- Coordinating Center available, data center unavailable
- Both Coordinating Center and data center unavailable

This 2011 OC/DR exercise identified a number of action items, most of which were resolved during the contract period:

- Lack of a defined off-site software repository with current production versions available: ***Resolved in 2012***
- Lack of VPN capacity to service 175 identified operational continuity recovery staff remotely: ***Resolved in 2012***
- Single point of failure with all Minnesota facilities connecting as spokes directly to the Broadway Ridge facility hub with only Broadway Ridge connecting to the data center: ***Resolved in 2012***
- The lack of dedicated contracted operational continuity recovery sites makes staff recovery capacity uncertain since potential sites are selected based on availability at time of disaster: ***Issue acknowledged; leasing and outfitting fixed recovery sites is cost prohibitive to implement.***
- Operational recovery following regional disasters impacting both the Coordinating Center and the data center will take at least six weeks, possibly longer. Currently there is no plan to recover in a timelier manner from this scenario until an alternate or backup data center is established outside of the Twin Cities: ***Issue acknowledged, cost prohibitive to implement.***

During the 2011 operational continuity exercise, 100 tasks were attempted by a total of 68 operational continuity recovery staff, 86% of tasks were successfully accomplished. Participating operations units included: Quality Assurance, Legal and Risk Management, Case Management, Human Resources, Patient Services, Donor Liaison Team, Public Engagement Team, Finance, Survey Research Group, Scientific Services, and the Center for Cord Blood.

The 2011 Operational Continuity Exercise successfully met these exercise objectives:

- Establish secure data center connectivity from an ad hoc Critical Staff Recovery Site.
- Establish Unified Communications (IP phones) at ad hoc Critical Staff Recovery Site.
- Assess ability of participating department staff to complete critical tasks.

This 2011 operational continuity exercise identified a number of action items, most were resolved during the contract period:

- Some of the terminal servers lacked the necessary links and programs needed for some departmental user access testing: ***Resolved 2012***
- Some users were reliant on remote access to desktop systems that may be unavailable during a severe business interruption to complete critical tasks: ***Resolved 2012***
- HR required access to a specific virtual drive (M drive) that could not be accessed remotely to execute payroll and benefits transactions: ***Resolved 2012***
- Check writing capacity requires specialized software, data files, and equipment to execute not available at recovery site: ***Resolved 2012***

To support the establishment of additional Operational Continuity Recovery Sites, supplemental long lead time equipment was purchased. This equipment is stored at the Repository Facility in New Brighton, Minnesota. Equipment purchases included powered VPN appliances, high capacity powered switches, wireless access points, and headsets for software phones.

To sustain communications with Network partners during a severe operational disruption, the NMDP maintains a variety of redundant channels. The NMDP has over 150 active Governmental Emergency Telecommunications Service (GETS) emergency calling cards issued to RITN centers and NMDP staff and over 60 Iridium satellite telephones assigned and distributed to external partners. Recurring tests of each of these capabilities ensured user familiarity and equipment accountability.

Site visits to several NMDP operated donor centers resulted in improved preparedness for NMDP field staff. A review of the NMDP Operational Continuity Action Guide with each site manager and their staff ensured they know what to do for the major hazards applicable to their location. Processes for closing offices due to local hazards and transferring critical activity to other facilities were refined.

II.B. Rapid Identification of Matched Donors – Hypothesis 1:

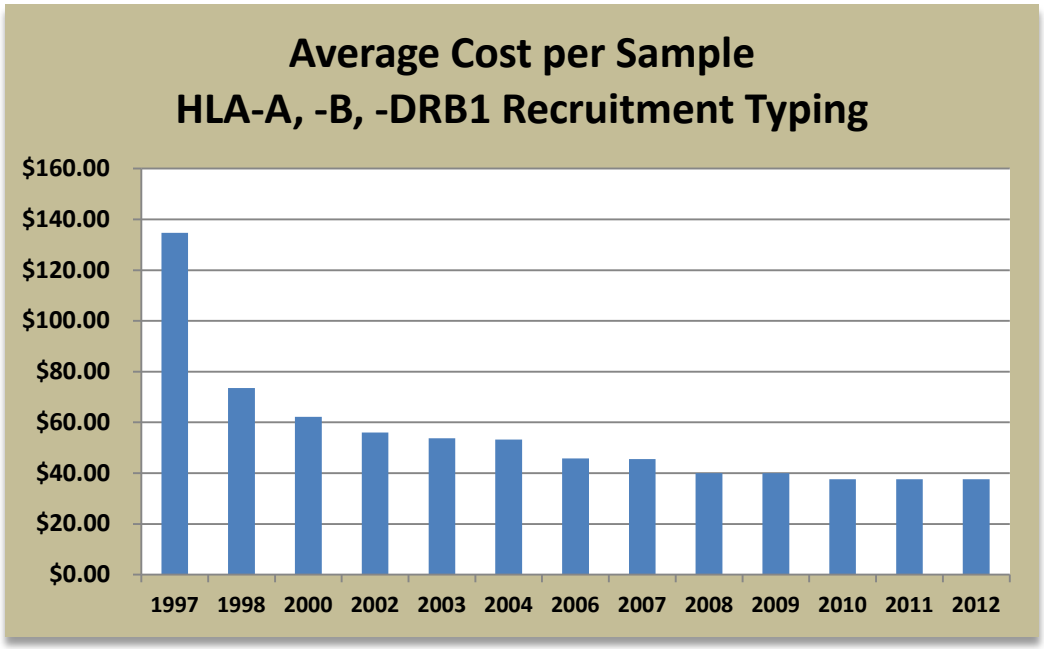
Increasing the resolution and quality of the HLA testing of volunteers on the registry will speed donor selection.

Advances in laboratory methods and supporting equipment continued to positively impact the level of quality and typing resolution for newly recruited volunteer donors. As of December 31, 2012, all newly recruited donors were being typed at a minimum of 3 loci (HLA-A, B and DRB1). 52% of these donors were being typed at 5 loci (adding HLA-C and DQB1), and 18% were being typed at 6 loci (adding HLA-C, DQB1 and DPB1). Furthermore, 41% of all donors were typed at laboratories used Sequenced Based Typing (SBT)

In an effort to maximize these resources and ensure the optimal use of typing funds, a process was implemented that allows selective typing based on donor characteristics. Samples from donors with particularly desirable demographics (male, younger age and minority) are directed to specific laboratories to ensure they are listed on the registry with the best typing possible.

Over the past 15 years, the NMDP has reduced the cost of HLA typing by over 70% while increasing typing resolution and quality (Figure 10). The vision and efforts of the Navy project officer to continually press the HLA community to lower costs and increase typing resolution and quality has been instrumental in achieving these accomplishments.

Figure 10. Cost Decreases for HLA-ABDR Typing



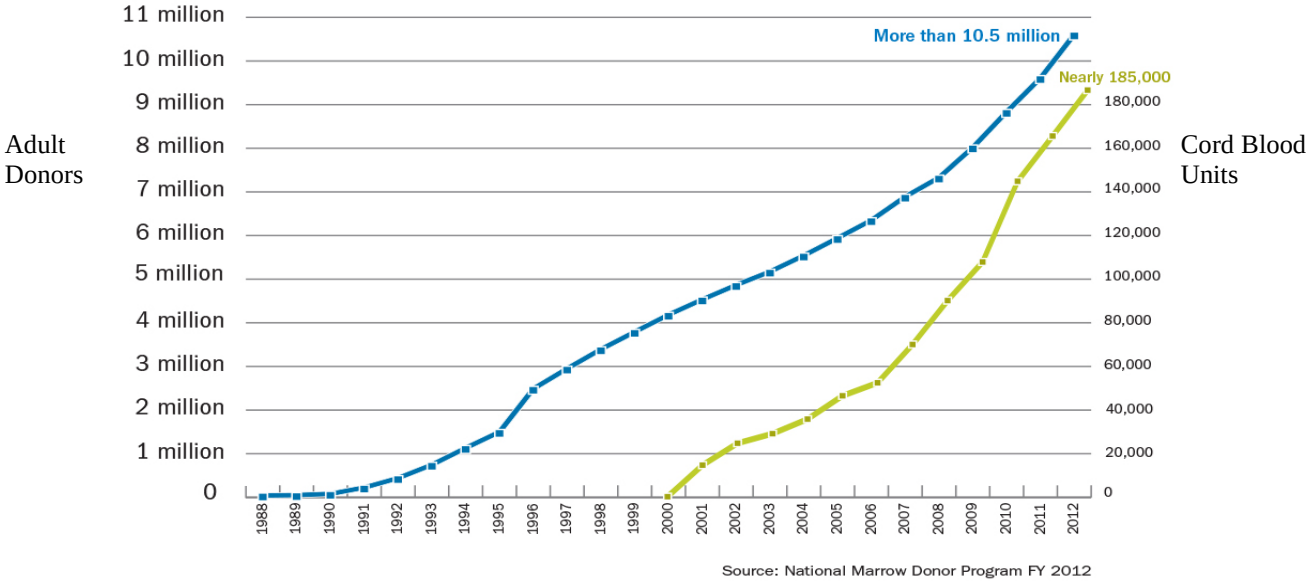
Average cost per sample for HLA-A, B, DRB1 recruitment typing has decreased over time, from more than $130/sample to less than $40/sample. While per sample costs have been relatively constant over recent years, it should be noted that the resolution of the results has continued to increase over time, thereby facilitating improvements in donor selection without increased cost.

If a patient does not find a matched donor and is in urgent need, patient-focused drives can be held and the donor registration process can be expedited, shortening the length of time to listing from 6-8 weeks to 3 weeks. This process includes time to enter demographic data, confirm financial coverage, ship and receive the samples and complete the HLA typing. Demographic data are entered within 72 hours for expedited samples, and they are shipped the next scheduled day, Monday through Thursday. In case of a contingency event, high volumes of samples could be processed and shipped quickly using this established process.

Aim B.1.1: Increase Registry Diversity

Newly recruited donors increased diversity
During NMDP FY11, NMDP donor centers (including DoD) and recruitment groups recruited 259,612 minority race and 249,104 Caucasian donors, for a total of 508,716 U.S. donors added to the Registry. Navy funding contributed to the addition of 143,280 of this culturally diverse group of new donors, with 46,834 of these donors being minorities. All donors were typed for a minimum of HLA-A, B, and DRB1.

Figure 11. Be the Match Registry Growth: Adult Donors and Cord Blood Units



New Donor Queue Sorting

To maximize the utilization of the HLA recruitment typing resources, a process was developed to strategically select samples from the newly recruited donor queue and direct these samples to specific laboratories. This process allows the NMDP to select donors, based on demographic data, and direct the testing to laboratories that provide the most complete and highest resolution HLA typing at the time of recruitment. The goal is to select the most valuable donors (young males, young females, and all minorities) and ensure they are listed on the registry with the most comprehensive typing available through the contract laboratory network.

This queue sorting process has provided a dramatic increase in the number of loci typed on the most valuable new donors joining the registry, which are male (M) and female (F) donors, 18-30 years of age. The below information shows the gender recruited with associated HLA typing:

January 2011:	95%	M&F	HLA-A, B, C, DRB1
December 2012:	23%	M	HLA-A, B, C, DRB1, DQB1
	77%	M	HLA-A, B, C, DRB1, DQB1, DPB1
	83%	F	HLA-A, B, C, DRB1, DQB1
	17%	F	HLA-A, B, DRB1

Advancing technology improved performance and pricing

Advances in laboratory methods and supporting equipment continue to have a positive impact on lab performance and pricing.

As of December, 2012:

- 97% of new donors received higher than intermediate HLA-A, B and DRB1 typing
- 52% of new donors had additional loci tested (HLA-C, DQB1 and DPB1)
- Blind quality control testing error rate was 0.08%, exceeding the project requirement of $\leq 2.0\%$.
- On-time testing completion rate was 99%, meeting the project requirement of a minimum of 90% of typing results reported within 14 days of shipment of samples.
- The cost of HLA typing continued to decrease as technology improved; in December 2012, the average price per sample was approximately $40.00 compared to $134.75 in 1997 ($181.17 in 2012), which represents a decrease of over 78%. Note that in addition to decreasing average cost, there were increases in the number of loci typed and resolution of results over this time period.

HLA Typing Laboratory Meetings

NMDP hosted individual meetings for representatives from all of the new member recruitment HLA typing laboratories to discuss operational topics including: the current scope of work,

future goals for registry HLA typing, and the laboratory's future HLA testing vision. These discussions were important to allow the NMDP to continue to provide low cost and high quality HLA typing for patients searching the registry. The consensus from the meetings was that the only immediate way to decrease costs of HLA typing was to increase the testing volume. In the longer term, laboratories are evaluating new and emerging technologies to decrease costs and increase resolution.

Quality of HLA Typing Improved

The NMDP maintains lists of rare alleles as a service to the American Society for Histocompatibility & Immunogenetics (ASHI). These lists are derived from HLA allele level typings of patients, adult volunteers, and cord blood units in the Be The Match Registry. In an on-going Registry data quality project, adult volunteers with reported HLA typing containing a rare allele were evaluated to determine if the results were accurate based the following rules:

1. Sample assignments showed previous corrections
2. Samples typed >four years ago and allele not subsequently observed
3. Alleles reported in a sample whose race differed from the race the allele was initially described
4. Interpreted primary data received from the laboratory not consistent with assignment
5. Rare allele consistently reported as a pair with the same second allele
6. Sample carried two rare alleles at the same locus.

During this contract period, 479 samples were typed at high resolution HLA-A, B, C, or DRB1. The rate at which results changed was 44.1%. Results from this grant period are detailed in Table 3. The cumulative testing for this allele retyping project funded by consecutive ONR grants shows that 903 (60%) donor typings changed from the previously reported rare allele and 605 donor typings were confirmed to carry the reported rare allele.

Table 3: Results of HLA retyping project

	# Typed	% confirmed	% changed
HLA-A	105	57.1%	42.9%
HLA-B	232	50.0%	50.0%
HLA-C	25	28.0%	72.0%
HLA-DRB1	117	72.6%	27.4%
Total	479	55.9%	44.1%

The results of these data were presented at the International Histocompatibility and Immunogenetics Workshop/European Federation of Immunogenetics, "Frequency of Rare Alleles Workshop" in May 2012. A poster abstract detailing the inaccuracy of DRB1*16:08 typing was also presented at this meeting.[1]

Results of these re-typing projects improved the HLA typing quality of listed adult volunteers and removed erroneous typing from the registry. During this contract period, one adult volunteer whose typing had been corrected through this project was requested for additional testing on behalf of a searching patient. The re-typing project highlights the importance of technical oversight of the Registry data and the necessity to upgrade typings routinely in order to provide the most accurate HLA data for searching patients.

Aim B.1.2: Evaluate HLA-DRB1 High Res Typing

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.1.3: Evaluate HLA-C Typing of Donors

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.1.4: Evaluate Suitability of Buccal Swabs

Sample Storage Research Study

The 5-year Sample Storage Research Study began in September 2007. Samples from 30 fully HLA characterized volunteer quality control donors were collected, processed and stored at the NMDP Repository. The samples consisted of fresh blood, blood spotted onto Whatman® 903 filter paper and buccal swabs for each donor, were sent to two laboratories in September 2007 to initiate the study (Time Point Zero). One laboratory was contracted to perform high resolution typing for HLA-A, B, C, DRB1, and DQB1. The second laboratory was contracted to perform intermediate resolution typing for HLA-A, B, C, and DRB1 and to evaluate the quantity and quality of DNA derived from each sample type. Complete results were received from each of the two laboratories. All typing results were 100% accurate, and the evaluation of the DNA was complete and thorough. The results obtained at Time Point Zero are used as the baseline for comparison and evaluation of the stability and usefulness of the DNA stored in each sample type for the next 5 years. Results from this study will provide key quality parameters for NMDP business decisions concerning sample storage and may also contribute sample storage guidelines for other registries.

During this grant period, the results for the Time Point at 4 Years (funded in previous Navy 0204 contract) and at 5 Years (funded under this grant) were evaluated. In September, 2011, and September, 2012, 30 donor samples (frozen blood, blood spotted onto filter paper, and 2 buccal swabs for each donor) were sent to the two participating laboratories. A summary of the data is shown in Table 4 below.

Table 4. Sample Storage Research Study Results

4 Year Time Point – 2011	5 Year Time Point – 2012
HLA Typing: • 100% accuracy for whole blood • 100% accuracy for filter paper • 100% accuracy for buccal swabs	HLA Typing: • 100% accuracy for whole blood • 99% accuracy for filter paper • 97% accuracy for buccal swabs
DNA Quantity: Sufficient for testing	DNA Quantity: Sufficient for testing
DNA Quality: Buccal swab DNA showing degradation • 5 swabs needed repeat testing	DNA Quality: Filter paper samples showing degradation, Buccal swab DNA showing more degradation than in 2011 • 14 filter papers needed repeat testing • 24 swabs needed repeat testing

Results show that DNA degradation issues first seen in Year 4 are tending to increase in Year 5, with buccal swabs showing degradation earlier than blood spotted onto filter paper. More details of the results will be published upon study completion. The NMDP is actively investigating alternative storage conditions that would provide greater long-term DNA stability for stored buccal swab samples, compared to the current controlled room temperature conditions. One option under consideration is storage of one buccal swab tip in a frozen state, for usage after long-term storage.

Aim B.1.5: Enhancing HLA Data for Selected Donors

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.1.6: Maintain a Quality Control Program

The NMDP's comprehensive quality control program ensures the quality of HLA typing received through the contract laboratory network. In addition, this program helps to ensure the accuracy of data obtained from research studies that support abstracts and publications. Blind quality control (QC) samples are added to each weekly shipment of new donor recruitment samples. These QC samples comprise 2.5% of each shipment, and are indistinguishable from the donor samples. The Research Sample Repository contains frozen cells from thousands of fully HLA-characterized donors and recipients. QC swabs are created by the Repository staff from expanded B-Lymphocytic cell line (B-LCL) vials chosen from this resource. The immortalized B-LCL cells are applied to cotton-tipped swabs and included as QC in shipments of buccal swab donor samples.

One hundred and sixteen samples were requested for cell transformation/initiation/culture/ expansion from the NMDP Research Repository for incorporation into the B-LCL QC HLA typing program. Of these, 16 (14%) exhibited negative cell growth. A total of 100 unique buccal B-LCL QC Masters were added to the inventory, 91 of which were confirmatory typed at high resolution SBT prior to incorporation into the database. Six percent of high resolution confirmatory types were discrepant with previous high resolution types obtained from the research database. These 100 samples help ensure that the NMDP QC inventory has near comprehensive coverage the Common and Well-documented (CWD) common US alleles, and expand alleles that were depleted to an n of 1 to maintain desired allelic diversity.

The remaining budget was used to fund high resolution typing of 9 of the 20 cord blood units that were obtained at no cost from the NMDP Cord Blood Bank Network for inclusion into the cord QC program, which nearly doubled the total number of cord blood units available for cord QC purposes. These 9 units were the remaining units requiring typing, as 11 were previously HLA typed using Navy funds in 2007, grant 0859, Aim IIB.3.2, Enhancement of EM Algorithm. The cord QC program uses blood spots derived from cord blood units to mimic the material supplied to the confirmatory typing laboratory for the NMDP Cord Blood Bank Network.

II.B. Rapid Identification of Matched Donors – Hypothesis 2:

Primary DNA typing data can be used within the registry to improve the quality and resolution of volunteer donor HLA assignments.

Aim B.2.1: Collection of Primary Data

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.2.2: Validation of Logic of Primary Data

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.2.3: Reinterpretation of Primary Data

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.2.4: Genotype Lists & Matching Algorithm

Next Generation Sequencing (NGS)

A meeting was held to initiate a Next-Generation Sequencing (NGS) Data Consortium in Puerto Rico at the annual ASHI meeting. This meeting brought together the main NGS technology vendors and large volume HLA typing laboratories to discuss data standards. The group identified the core elements of a Minimum Information for Reporting an Immunogenomic Genotyping Experiment (MIRIGE) MIBBI-type standard (Minimum Information for Biological and Biomedical Investigations). The presentations and outcomes of these meetings are available online at www.immunogenomics.org/ngs.

Health Level 7 (HL7)

The NMDP became a member of HL7 (Health Level 7), and began evaluating HL7 messaging type (v3 vs v2), methodology, and development tools caBIG Life Sciences Domain Analysis Model (LS-DAM). Contact was initiated with the LS-DAM group and a plan was established to include HLA in LS-DAM (either map to current model or expand to include new concepts as needed)

NMDP staff joined the Clinical Genomics (CG) Workgroup to develop constrained CDA for reporting HLA typing. Developed 1st draft using the Model-Driven Health Tools (MDHT) from Open Health Tools. ://www.projects.openhealthtools.org/sf/projects/mdht/). A first draft of an CDA Implementation Guide for reporting HLA was created using the MDHT tool. We used the existing CDA project files which have already been constrained to create a Genetic Test Report by the HL7 Clinical Genomics Workgroup. This was further constrained using the MDHT tool. This tool allows us to automatically generate an Implementation Guide after constraining the structured document for HLA reporting requirement (Silver Standard). Required sections that were previously optional include Genetic Variation (Findings and Interpretations) and Test Information Section, which includes Background, Methodology, and References. Most of the effort to date has been on the structured data of the Test Details section and in how results can be encoded in GL String format.

- A collaboration was established with Amnon Shabo (co-chair of HL7 Clinical Genomics Work Group) to work on:
  1. Exploring use of HL7 Clinical Genomics Work Group's Genetic Testing Report (GTR) as a template for HLA typing reports. The GTR is an implementation of the HL7 CDA (Clinical Document Architecture).
  2. Developing a RMIM (Refined Message Information Model) based message that would encapsulate HML into the message
  3. Establishing collaborations with Hadassah Hospital and Northwestern University for potential pilot of exchanging HLA data in HL7 message. Hadassah and Northwestern have been communicating with the HL7 CG working group about messaging standards for tissue typing. A use case is being developed between both organizations` and NMDP to be used to develop HL7 messaging standards that embody Silver Standard principles.

- The HL7 and LSDAM resources/activities were presented to the HIEDFS group (HLA Information Exchange Data Format Standards). This is a consortium of 10 commercial HLA typing kit vendors.
- Initiated discussions with Mike Feolo and NCBI staff to develop use of GTR (Genetic Testing Registry) for meeting Silver Standard principles for methodology reporting of HLA typing. The GTR is a Clinical Document Architecture (CDA) document constrained for genetic testing by the HL7 CG working group.

GL String and GL Service

Web services were developed that create, update, and retrieve HLA typing data in standardized formats without the need for allele codes and their inherent introduction of new ambiguities. ReSTful (Representational State Transfer) web services with content-aware negotiation are being developed employing a Java library that manages HLA typing data using standardized formats. These formats include the XML based Histoimmunogenetics Markup Language (HML), and a simple character deliminated string format able to encode HLA typing with its ambiguity (GLString). Resources are identified with a simple URI (Universal Resource Identifier). The services access a database containing IMGT/HLA data which is updated quarterly, and objects such as alleles, lists of alleles, haplotypes, genotypes, and lists of genotypes. Public services include creating, deleting, updating, and retrieving these objects. Content negotiation allows retrieving these data in a variety of formats including GL String, HML, HTML, JSON, and QRCodes. The tools being developed provide the HLA lab a common resource for managing HLA data in a standardized way.

- A code repository was established (://code.google.com/p/genotype-) and source code and documentation released under GNU LGPL.
- A demo was deployed of Silver Standard genotype list RESTful web service on Amazon EC2 cloud at ://gl.immunogenomics. as a foundation for feedback and presentation at the American Society for Histocompatibility and Immunogenetics (ASHI) 2012 Meeting, “Tools for Implementation of Silver Standard Principles for HLA Typing”

TIDES

- A Toolkit for Immunogenomic Data Exchange and Storage (TIDES) has been developed as a demonstration of tools that use the GL Service. The tool has the ability to convert HLA genotyping data generated by three different commercial typing platforms (StripScan, HLA Fusion, and Assign ATF) into GL Strings, registering them with a GL Service, and returning URIs which are stored in a database. Further development includes: data queries, CGI upload, and format transformation, deployed on an EC2 instance on the Amazon cloud (://tides.immunogenomics.).

IMMPUTE

An initial project meeting was held with collaborators on the IMMPUTE project (to evaluate 5 algorithms performance on the imputation of HLA from SNPs in the MHC region). A detailed experimental plan has been drafted. This project includes statistical evaluation of population differentiation within the 1000 Genomes and Human Genome Diversity Panel (HGDP) datasets for the purpose of training and testing the various algorithms.

The following research groups are participating in this project:

- Bruce Weir, Department of Biostatistics, University of Washington
- Jerek Meller, Cincinnati Children's Hospital Medical Center
- Gil Mc Vean, Statistical Genetics at the University of Oxford, UK
- Paul de Bakker, Brigham and Women's Hospital and Harvard Medical School, USA
- Lue Ping Zhao, Shuying Li, Division of Public Health Sciences, Fred Hutchinson Cancer Research Center

Correlations between SNP datasets, regional (ancestry) groups and HLA types have been established and a website for distribution of datasets to participants has been established.

Traxis

- A prototype implementation of Traxis was developed with changes to user-interface to display most likely alleles and show alternative genotypes. This is a pre-requisite to relaxing the need to encode HLA typing data into allele codes at the laboratory and allowing genotype lists to be reported and used for matching and on search reports.

II.B. Rapid Identification of Matched Donors – Hypothesis 3:

Registry data on HLA allele and haplotype frequencies and on the nuances of HLA typing can be used to design computer algorithms to predict the best matched donor.

Aim B.3.1: Phase I of Expectation Maximization (EM) Haplotype Logic

During the grant period a new version of the algorithm was implemented (Dec 19, 2011) which includes a number of medical and technological enhancements.

The primary new functionality is that the algorithm can compute the probability that the donor typing will match the recipient at high-resolution across 5 HLA loci (HLA-A, B, C, DRB1 and DQB1) rather than the 3 loci (HLA-A, B, DRB1) used in the prior implementation. This aligns with clinical practice of considering 4 or 5 HLA loci by providing x of 8 or x of 10 match likelihood predictions. The population data resources have been greatly expanded to include haplotype frequencies derived from 5 broad and 18 detailed race/ethnic groups.

The algorithm application was migrated from the "C" programming language to Java in order to improve performance, flexibility and connectivity. The database backend was migrated from the Sybase STAR (Search Tracking and Registry) to a new Oracle database. The technical enhancements lead to a significant decrease in median search times to 35 seconds (fig. 12)

Other activity under this aim during the grant period:

- A new webservice was created called ComputeMatchService that computes match results given any two sets of search typings. This allows access to the algorithm from other applications and for R&D use.
- Further development took place of an automated process to refresh the haplotype frequencies used for matching.

Figure 12. Search run times over the past year.

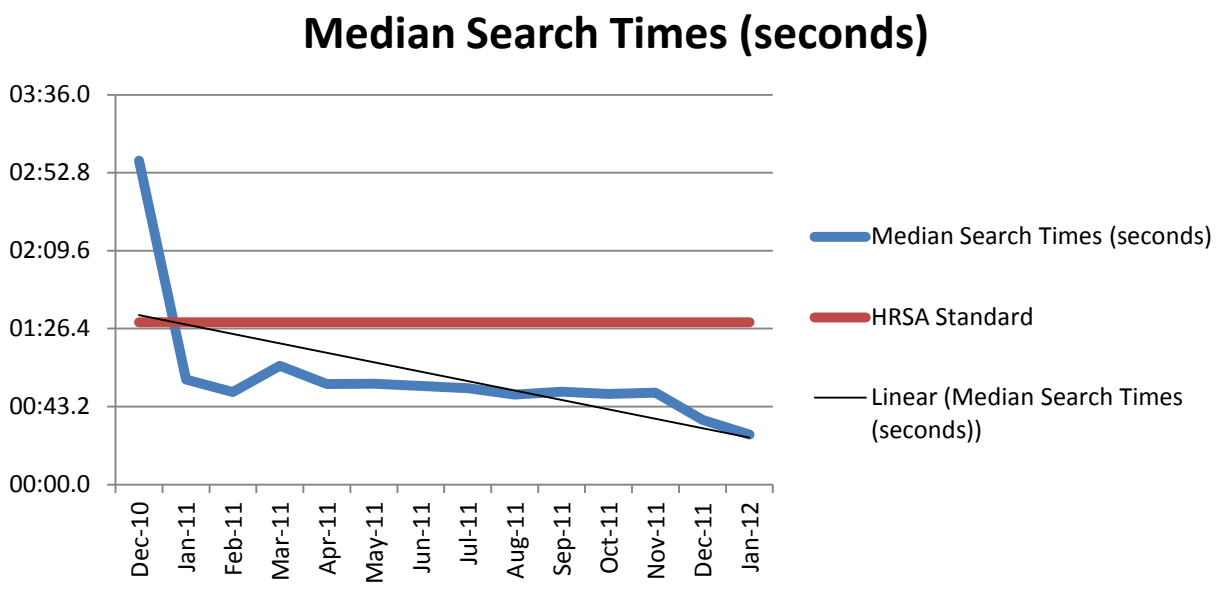


Figure 13. Expected vs. actual predictions for 10 of 10 matching using the updated version of HapLogic.

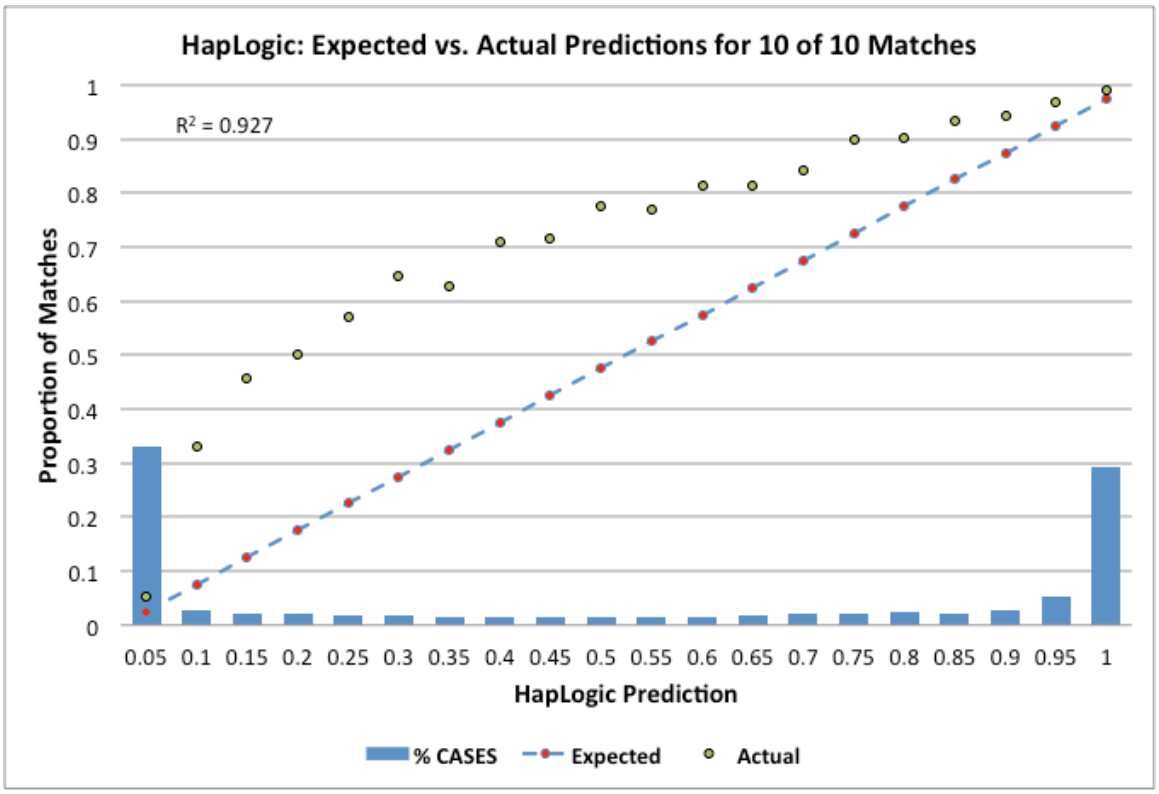


Figure 13 shows the results of a validation experiment on ~60,000 typing requests where the prediction is based on the assessment of the patient/donor combination before additional HLA typing (5%-ile categories on the X-axis) and the proportion of these cases resulted in an "actual" match (at 10 of 10 alleles) indicated with green dots on the Y-axis. The blue bars show the proportion of cases in each prediction category with the majority being at the extremes (<0.05 or >0.95). The red-dots and dashed line represents the expected proportion of matching cases. Deviation (uniformly in the direction of pessimism on the part of the algorithm) is attributable to a number of factors (insufficient haplotype frequencies, population structure, admixture or any other deviation from Hardy-Weinberg proportions) and is an area for further research.

Aim B.3.2 Enhancement of EM Algorithm

New Registry Haplotype Frequencies

- New 6-locus A~C~B~DRB3/4/5~DRB1~DQB1 haplotype frequencies were computed on 21 detailed race populations and 5 rollup race populations using Blocks/Imputation EM approach on the entire DNA-typed registry.
- A testing framework was developed to evaluate the new 6-locus haplotype frequencies in a version of the HapLogic III matching algorithm and found significant improvements in predictions of allele matching compared to the production previous haplotype frequency dataset.
- A complete reinterpretation all available registry SSO probe data to HLADB 3.8.0 was completed and work was initiated to streamline the process for calculation of updated US haplotype frequencies to prepare for this to become an ongoing activity.
- The first draft of manuscript describing 6-locus haplotype frequency data was circulated to co-authors.

HLA-DP Haplotype Frequencies

- DPA1~DPB1 haplotype frequency manuscript was published in the journal Immunogenetics.[2]

Global Haplotype Frequencies

- A project was initiated to analyze the haplotype frequencies of all registries in BMDW. This frequency data is a pre-requisite to being able to accurately assign matching likelihoods for international donors and cord blood units presented on NMDP search reports.
- A novel method has been developed to improve 5-locus BMDW haplotype frequencies by using linkage information from similar populations. This is important to be able to provide 4 and 5-locus assignments for registry where there only 3-locus typing data.
- The IHIW registry diversity working group has the goal to validate bioinformatics methods and tools for HLA haplotype frequency analysis specifically addressing unique issues of hematopoietic stem cell registry data sets. This group met at the IHI conference in Liverpool (July 2012). A manuscript was drafted to summarize the results of the first

3 phases of experiments from this project.[3] A meeting report summarizing tasks 3, 4 & 5 for the IHIW registry diversity working group was drafted and submitted to the International Journal of Immunogenetics.[4]

Aim B.3.3 Optimal Registry Size Analysis

An abstract on cord inventory modeling for study on CCR5-delta32 cord transplantation as potential HIV cure was accepted for an oral presentation at the 2012 BMT Tandem meetings:

- Petz, Tonai, Redei, et al. Cord blood transplantation for long term management or possible cure of HIV infection. Biol Blood Marrow Transplant 2012. 18(2s): S215. Abstract O35.

Aim B.3.4: Target Under-Represented Phenotypes

HaploStats

A new version of the HaploStats application (haplostats.org) was released. This is a public web-based tool to look-up haplotype frequencies based on an user-input HLA genotype. During this grant period the program was re-designed to accommodate the new haplotype frequency data from 21 detailed and 5 broad race/ethnic populations.

A series of global haplotype frequency maps have been generated and are available via the haplostats application based on links associated with the individual HLA haplotypes. This tool was presented at the 2011 EFI, ASHI and ASHG meetings. The program was also presented by Vicky Turner from St. Jude Children's Research Hospital at the 2011 IHIW conference. Additional user documentation has been added to the HaploStats application describing the new functionality.

Imputation Database (IMP_RES)

A new relational database was developed to store the results of HLA imputation for all registry donors, patients and cord blood units. This database uses the haplotype frequencies and computational principles of HapLogic to associate a series of phased haplotype pairs with with each individual HLA type. This is a foundational tool for future research initiatives and will support geospatial analysis, population modeling, CIBMTR research matching and disease association analyses.

AQP

An Ancestry questionnaire pilot (AQP) study was initiated to introduce enhancements to the ancestry questionnaire used by donors to join the registry. This study has been approved by the NMDP IRB and opened accrual in Oct. 2012 with the goal of enrolling 3000 subjects. This study will evaluate a novel self-identified race and ethnicity (SIRE) questionnaire and genetic ancestry informative markers in a sample of individuals from within the registry.

II.B. Rapid Identification of Matched Donors – Hypothesis 4:

Reducing the time and effort required to identify closely matched donors for patients in urgent need of HSC transplants will improve access to transplantation and patient survival in the context of a contingency response and routine patient care.

Aim B.4.1: Expand Network Communications

No funding was requested for this Aim during the 0339 budget cycle.

Aim B.4.2: Central Contingency Management

7/8 Donor Match Rate Study

A previous Navy funded research project estimated the 8/8 (HLA-A, B, C and DRB1) high resolution donor match rate for the four largest NMDP patient populations: Caucasian (CAU), African American (AFA), Hispanic (HIS), and Asian-Pacific Islander (API).[5] As a second phase, a research project was developed and completed this period to estimate the 7/8 HLA high resolution donor match rate, given this is a suitable match level for transplantation of an unrelated donor. The project also re-evaluated the 8/8 high resolution match rate which was previously determined using a 2009 donor registry snapshot. The same cohort of 'pseudo-patient' searches used in the 2009 study was used again to determine 7/8 match rate and to determine any updates in the 8/8 match rate since 2009. This study used a NMDP registry file from January 2012. The goal of the study was to validate previous registry benchmark analyses performed computationally and supply valuable information regarding donor selection in the event of a contingency. The project was presented to the NMDP Histocompatibility Advisory Group and approved as designed.

During the project period:

- Scientific Services experts in HLA search strategy completed donor selections on behalf of the study 'pseudo-patients' for four racial cohorts.
- A contract was established with an HLA testing lab.
- Donors with repository samples were tested to identify the 7/8 and/or 8/8 HLA high resolution match rate for 'pseudo-patients' in the four major race categories- CAU, AFA, HIS, and API.
- A total of 5130 donors and 6386 loci were typed during this project period.

- Analysis of the donor typing results was performed to determine the match rate for 'pseudo-patients' in the four cohorts
- 9/10 and 10/10 match rates (includes HLA-DQB1) were also determined for all four race groups

Results (nearly complete) for the project period are shown below.

Figure 14 shows the 7/8 match rate of cases by race group. A distinct difference in the 7/8 match levels between CAU (~98%) and non-CAU patients (~81-87%) is apparent.

Figure 14. 2012 7/8 High resolution match rate.

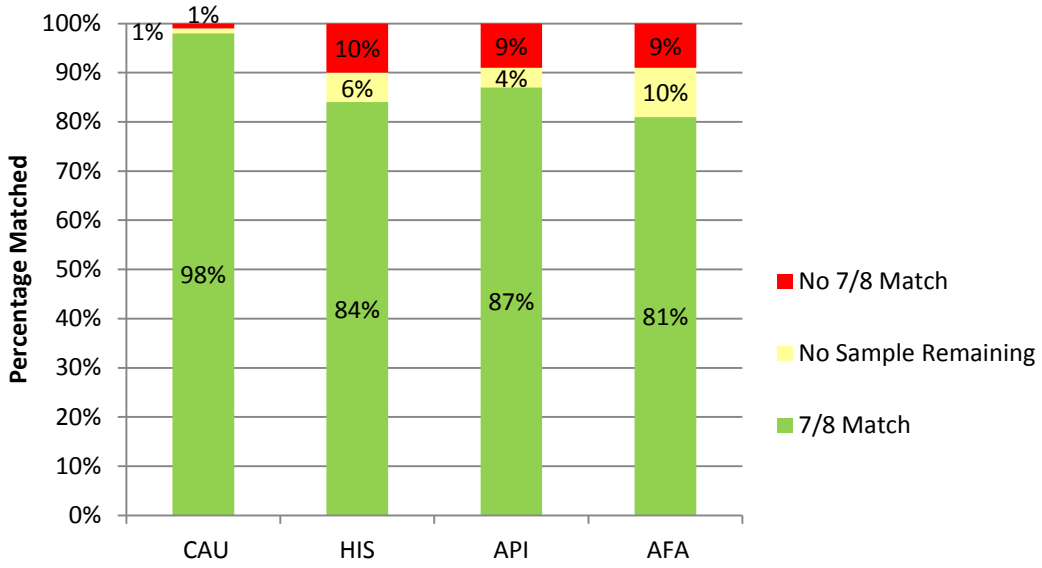


Figure 15 shows the updated 8/8 match rate of cases by race group. This graph shows the match rate differences across race groups, with CAU having the highest 8/8 matching and AFA having the lowest. These data also showed improvement from the 2009 dataset match rate of ~2-3% for each group due to an additional 3 years of donor recruitment to the NMDP registry.

Figure 15. 2012 8/8 High resolution match rate

Figure 16 shows the 9/10 match rate of cases by race group. This shows the drop in match rate when HLA-DQB1 is considered. Due to tight HLA DRB1/DQB1 haplotypes, many DRB1 mismatches also result in an additional DQB1 mismatch.

Figure 16. 2012 9/10 High resolution match rate

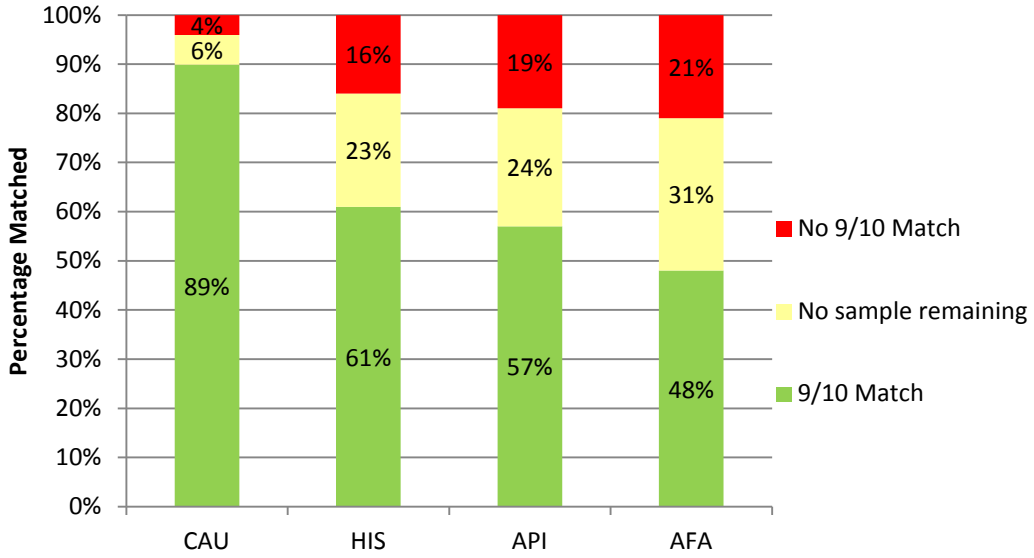
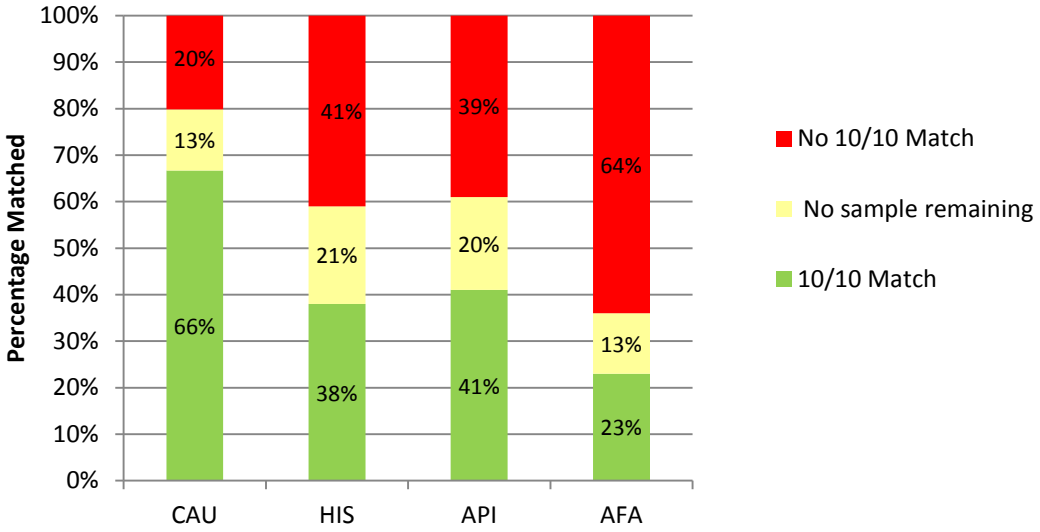


Figure 17 shows the updated 10/10 match rate of cases, by race.

Figure 17. 2012 10/10 High resolution match rate



This study is near completion. Further data analysis is being performed with plans for an upcoming abstract and manuscript. The results of this study are important for transplant center physicians and coordinators understanding of the likelihood of finding a match on the NMDP Registry when consulting with patients. This information is also vital to the NMDP's ability to understand and continue to focus on improving the match rates for incoming patients of all backgrounds. Further investigation is needed to understand the importance of retaining available donors as the match rates from this analysis are based on genetic availability. In practice, the ability of a matched donor to proceed to donation can also impact the HLA match level of a transplanted patient, with patients of non-caucasian backgrounds more likely to have only a single genetic match, an unavailable donor can mean the difference between an 8/8 and a 7/8 matched transplant.

Transplant Center Search Proficiency Study

The TC Search Proficiency Study was initiated to understand the current donor selection practices of United States (US) transplant centers. The searches at each transplant center were evaluated and rated based on specific criteria to calculate a proficiency score. The results were analyzed to determine if there were transplant center factors that correlated with high search strategy proficiency.

An earlier study in 2005 occurred prior to the addition of Haplogic™ predictions and donor sorting on patient searches.[6] Since the 2005 study, NMDP search strategist staff have provided comprehensive search strategy training and education tracks at our annual NMDP Council

Meetings along with webinars and presentations to internal and external staff. The two studies were compared to determine if there were changes in proficiency over time.

The 2011 TC Search Proficiency study design was reviewed and approved by the NMDP Histocompatibility Advisory Group in March 2011. The study selected and evaluated up to five random searches from each US Transplant Center. Each search was reviewed at the point of initial TC donor selection. The searches were reviewed for search proficiency which was calculated based on an algorithm to rate searches for three factors. The possible ratings (0-3 scale) for each of the three factors were summed for an overall score for each search where 9.0 was the highest rating. The three factors included:

1. Resolution of Patient HLA typing (loci and HLA resolution)
2. Adequate number of donors selected
3. Search Strategy

The searches were archived at the time of first donor selection. The study began accrual in June and continued through September 2011 when there were 556 searches evaluated from 130 TCs. The searches were stratified as high proficiency if they were rated a perfect score (9.0) or rated low proficiency if they had less than a perfect score (< 9).

- 76% rated in the high proficiency group
- 24% rated in the low proficiency group

The most frequent characteristic of searches in the low proficiency group was the selection of an inadequate number of donors. This has potential to delay a search because of the need to select, contact, and HLA type additional donors.

The results were compared to the searches evaluated in the 2005 TC Proficiency Study. The transplant centers improved their search proficiency from 52% in the high proficiency group in 2005 to 76% in 2011. From 2005 to 2011, NMDP initiated a new Custom Search Support (CSS) search service, HapLogic matching predictions and sorting, and educational initiatives which may have had an impact on this increase in searches in high proficiency group.

The study included univariate and multivariate statistical analyses of search specific factors that correlated to higher proficiency ratings. The factors and the statistical significance (using P value of <0.05) results are included below and in Table 5:

1. TC Procurement level (not significant)
2. Use of Custom Search Support (significant)
3. Use of Search Strategy Advice (not significant)
4. Presence of Certified Hematopoietic Transplant Coordinator (CHTC) on staff (significant)
5. Not a Difficult search (significant)

Table 5. Logistic Regression Results for Search Proficiency Rating

Factor	N	OR	(95% CI)	p-value	Favorable characteristic
Procurement Level				0.073	Not significant
Low	81	1.00			
Medium	350	1.89	(0.84-4.25)	0.127	
High	135	1.05	(0.45-2.46)	0.907	
CSS sent to TC before Formal					CSS sent to TC before Formal
Yes	71	4.13	(1.39-12.28)	0.011	
No	495	1.00			
SSA sent to TC before Formal					Not significant
Yes	32	1.13	(0.47-2.74)	0.781	
No	534	1.00			
At least 1 CHTC staff					Had at least 1 CHTC staff
Yes	239	2.07	(1.22-3.50)	0.007	
No	327	1.00			
Difficult search					
Yes	226	0.63	(0.42-0.93)	0.020	Not difficult
No	340	1.00			

OR= odds ratio; CI= confidence interval

The TC Search Proficiency Study initial results (accrual through September 2011) were presented as a poster abstract at the February 2012 BMT Tandem annual meeting.[7]

Study enrollment continued through December 2011 with the addition of 53 searches and two transplant centers. The final data set consists of 619 searches from 132 transplant centers. The final data are being used for statistical analysis and the results will be prepared as a manuscript planned for early 2013.

Additional Presentations

Kevin Tram, et al, Considering HLA-C matching for single cord blood unit transplants, Poster presentation at 2012 ASHI annual meeting. In brief, a cohort of primarily pediatric single CBU transplants from December 2011 to February 2012 (n = 119) was examined to determine if a more fully matched x/8 (antigen level at HLA-A, B, C and allele level at HLA-DRB1) unit was available in the Be The Match Registry®. Of the 119 single CBU transplants assessed, 79 (66%) of the transplants had the best matched unit while 40 (34%) had a better matched unit available. The cell dose of the better matched unit was higher in 42.5% of cases, with the median change in cell dose of -9.3%.[8]

Jason Dehn, et al, A/B only typed donors: Possible but improbable 6/6 HLA allele matches, Poster presentation at 2012 ASBMT/CIBMTR Annual Tandem Meeting. In brief, we identified 180 new patient searches with no potential 6/6 HLA allele matched donors, reviewed the search results, and typed DRB1 on a total of 2,976 A/B only donors found on the patient searches with stored DNA samples in attempt to identify a matched donor. Of those tested, two donors matched their respective patient at 6/6 and one donor became the only 10/10 allele matched donor. That patient proceeded to a successful transplant. Overall, this study showed limited benefit to testing donors who are only typed at HLA-A/B, so strategies to pursue this testing may be best accomplished in tandem with the selection of the best mismatched donors. Future studies evaluating how the A/B only pool can support finding the best 9/10 or 7/8 match for patients are being considered [9]

Aim B.4.3 Conduct a transplant center benchmarking analysis to identify center-specific factors (e.g., quality management techniques and processes) that contribute meaningfully to superior survival outcomes. Share processes that contribute to superior outcomes with the entire TC network as best practices.

No funding was requested under this Aim for the 0339 budget cycle.

Aim B.4.4 Identify plans to expand capabilities of collection center and apheresis center network to meet increasing number of donor product requests on both a short-term and long-term basis.

No funding was requested under this Aim for the 0339 budget cycle.

II.C. Immunogenetic Studies – Hypothesis 1:

HLA mismatches may differ in their impact on transplant outcome, therefore, it is important to identify and quantify the influence of specific HLA mismatches. In contingency situations it will not be possible to delay transplant until a perfectly matched donor can be found.

Aim C.1.1: Donor Recipient Pair Project

In 1994 a retrospective D/R Pair HLA typing project to characterize class I and class II alleles of donor/recipient paired samples from NMDP's Repository was initiated. The goals of this ongoing research project are to assay the impact of DNA-based HLA matching on unrelated donor transplant outcome, develop strategies for optimal HLA matching, evaluate the impact of matching at alternative HLA loci on transplant outcome and finally to promote the development of DNA-based high resolution HLA typing methodologies. Presence/absence typing of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1) has been included.

- Typing was completed and final results were received on the 295 umbilical cord blood/recipient pairs of 110 unrelated donor/recipient pairs. All 405 pairs were typed for HLA and KIR. Linkage, no make and discrepancy resolution was initiated.

- To date over 2400 pairs and 1180 additional donors have been typed for presence/absence of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1).

Current HLA matching guidelines for unrelated HCT recommend avoidance of mismatches only within the Antigen Binding Domain (ABD). This recommendation is based on the hypothesis that amino acid differences outside the ABD are not immunogenic. The ABD allo-reactivity assessment project will give insight into the allowable percent tolerance of matching needed outside of the ABD.

We initiated investigation of a class II non-ABD mismatch (DRB1*14:01:01/14:54) where both alleles were seen in the same genotype. Seventy two donors were invited to participate in the study. Twenty one study participants consented and submitted blood samples. Eleven donor pairs representing four distinct haplotypes pairs were selected for in vitro testing. The initial results showed 1 of 6 tested combinations to be alloreactive to the non-ABD mismatch in both the mixed lymphocyte culture and ELIspot assays. Confirmatory tests were performed to determine whether the alloreactivity was due to the non-ABD mismatch or disparity at HLA-

DRB3, which was mismatched in the specimens. The confirmatory tests will incorporate blocking antibodies to DRB3 to isolate the impact of the DRB1 disparity.

Initial investigation of the class I non-ABD mismatches (A*02:01/02:09, B*44:02/44:27and C*07:01/07:06) where both alleles are believed to be in the same genotype have been performed. Specific queries of the Be The Match Registry allowed for selection of one hundred and forty potential donors to be typed at high resolution for the class I locus of interest. Class I typing was performed and it was determined that the B*44:02/44:27 would be the best candidate for complete typing. Typing at all loci for 53 donors occurred but results showed that the alleles did in fact segregate to two distinct haplotypes and are not useful for further testing. Analysis of other potential alleles is ongoing.

II.C. Immunogenetic Studies – Hypothesis 2:

Even when patient and donor are HLA matched, GVHD occurs so other loci may play a role.

Aim C.2.1: Analysis of non-HLA loci

Recent research has heightened interest in additional genetic polymorphisms which may modify the outcomes of transplantation. HLA genes other than the major histocompatibility complex (MHC) found on chromosome 6 and non-HLA genetic factors may all influence the suitability and success of allogeneic stem cell transplants.

Immunobiology Integration DataBase (IIDB)
This database was developed to allow the integration of research HLA typing and repository sample data from NMDP with the clinical outcomes data from CIBMTR. A monthly process to generate an "HLA Save file" with HLA and match grades for clinical outcomes research has been integrated into the IIDB database after significant progress in quality assurance testing. A "data quality" schema was created for collection of HLA validation error to be used for metrics and error resolution when validating HLA data from external sources and CIBMTR outcomes forms.

Clinical Ancestry Study
A new study proposal has been submitted to the CIBMTR Immunobiology Working Group to study the effect of matched genetic ancestry of donors and patients on transplant outcomes. This study was accepted and preliminary experiments have been run to investigate SNP panels as analysis tools for this study. A poster describing this study was presented at the 2012 BMT Tandem meetings.

The Immunobiology Project Results (IPR) database
This database and its applications allow for storage and analysis of all immunogenetic data collected on NMDP research samples. This database has replaced the existing HLA donor/recipient pair's database and facilitates storage and analysis of data from other immunogenetic loci.

During this period many bug fixes and minor enhancements within both reports and tools have been performed. Full support for multi-donor transplants has been added and several enhancements to improve the look-and-feel of the application were completed.
Key accomplishments during the last period:

1. Hover-over expansion of allele codes in reports and tools
2. Expanded capability to search for alleles. The entire database may now be searched
3. Migrated historical data from the High Res database into IPR

4. Migrated the IPR applications to more powerful servers
5. New reports produced
    a. ID
    b. Completed Pairs
    c. Discrepancy
    d. N of X
    e. Pre and post DRB1, 3/4/5 and pre and post B/C linkage
    f. Study data representation

Immunobiological test results generated through NMDP/CIBMTR approved studies and reported to the NMDP are summarized in Table 6. These data will be used for testing, validation, and population of the IPR database.

Table 6. Immunobiology typing projects utilizing NMDP samples and contributing data to the IPR database

Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
NK Cells, Their Receptors and Unrelated Donor [11]	J. Miller	2300 pairs	KIR	RT-PCR, FACS, SSO, MALDI-TOF	Yes
Survey of Diversity of Immune Response Genes in Unrelated Hematopoietic Stem Cell Transplantation	C. Hurley	40 Pairs	cytokine and KIR	SBT	Yes
Candidate Gene Study to Examine the Impact of Chemokine and Chemokine Receptor Gene Polymorphisms on the Incidence and Severity of Acute and Chronic	R. Abdi	1300 pairs	CCL1, CCL2, CCR5, CCR2, CX3CR1	Taqman PCR	Yes
Functional Significance of Killer Ig-like Receptor (KIR) Genes in HLA Matched and Mismatched Unrelated	B. Dupont, K. Hsu	2000 pairs	KIR	SSP	Yes
Functional Significance of Cytokine Gene Polymorphism in Modulation Risk of Post-Transplant Complications	E. Petersdorf	2500 pairs	>30 Immune response genes	Taqman PCR	Yes
Identification of Functional SNPs in Unrelated [16]	E. Petersdorf	3500 pairs	Entire MHC region	Taqman PCR	In Process

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Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
Use of Female Donors with Pre-existing Antibody to H-Y Antigen will Result in Robust Serologic Response to H-Y Antigens in Male HSC transplantation Recipients	D. Miklos	288 pairs	H-Y Antigen	ELISA, protein array	Yes
Multiplexed Genotyping of Human Minor Histocompatibility Antigens (mHAg): Clinical Relevance of mHAg Disparity in Stem Cell	T. Ellis	730 pairs	mHAg	Allele-specific Primer Extension	Yes
Genetic Polymorphisms in the Genes Encoding Human Interleukin-7 Receptor-a: Prognostic significance in Allogeneic Stem Cell	K. Muller	851 pairs	IL-7	Taqman PCR	Yes
The Effect of Non-Inherited Maternal Antigens in Cord Blood	L. Baxter-Lowe	102 pairs	HLA	SBT	Yes
Detection of HLA Antibody in Single Antigen HLA-Mismatched Unrelated Donor Transplants	S. Arai, D. Miklos	200 pairs	Anti-body	ELISA, Protein array	Yes
Detection of Donor-Directed, HLA-Specific Alloantibodies in Recipients of Unrelated Stem Cell Transplantation and Their Relationship to Graft/Patient	R. Bray	111 pairs	Anti-bodies	Flow cytometry	Yes
Genome-wide Association in Unrelated Donor Transplant Recipients and Donors: A Pilot Study	R. Goyal	858 pairs	> 600,000 Genome wide SNPs	Human 610 - Quad V1 arrays	In process
SNPs in the p53 Pathway and Outcomes in URD HCT	B. DuPont	1500 pairs	p53, ATM, MDM2 and p21/Waf1	Taqman	In process
Association of Donor and Recipient Gene Polymorphisms of Drug and Innate Immune Response with Outcomes after URD HCT	V. Rocha	725 pairs	GSTP, GSTT, GSTM, UGT CD14, TIRAP, and NALPs	Taqman	In process

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HLA Typing for Bone Marrow Transplantation
FINAL REPORT
January 1, 2011 – December 31, 2012

Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
To Develop and Test a Prognostic Index for Survival in CML URD	A. Dickinson	1100 pairs	TNF, IL-1RA and IL-10	Taqman	Yes
Evaluation of TGF-β1 Promoter and Signal Peptide Polymorphisms as Risk Factors for Renal Dysfunction in HCT Patients Treated with Cyclosporine	R. Shah	400 samples	TGF-β1	Taqman	Yes
Donor and Recipient Telomere Length as Predictors of Outcomes after Hematopoietic Stem Cell Transplant in Patients with Acquired Severe Aplastic Anemia	S. Gadalla	650 samples	Telomere length and Telomerase Polymorphisms	Taqman	In process
Development of a GVHD Prevention Biodiagnostic Test	R. Somogyi	450 samples	Gene Expression Array	Array	In process
Genetic polymorphisms and HCT related mortality Re: Pre-HCT conditioning in matched unrelated donor HCT	T. Hahn	>4,000 pairs	GWAS	Array	In process
Impact of CTLA4 SNPs on outcome after URD transplant	M. Jagasia	1,200 pairs	CTLA-4 SNPs	Taqman	In process
KIR genotyping and immune function in MDS patients prior to unrelated donor transplantation	A. E.Warlick and J. Miller	970 samples	KIR genotype, expression and cellular function	SSP, flow cytometry and cellular assays	In process
Plasma YKL-40 anc CHI3LI genotype to predict mortality after unrelated donor HCT	B. Kornblit	800 pairs	YKL-40 plasma levels and CHI3LI SNPs	ELISA and Taqman	In process
Natural killer cell genomics and outcomes after allogeneic transplantation for lymphoma	V. Bachanova, J. Miller, D. Weisdorf and L. Burns	800 pairs	KIR genotype, expression and cellular function	SSP, flow cytometry and cellular assays	In process
Effect of genetic ancestry matching on HSCT outcomes	A Madbouly, M. Maiers and N. Majhail	2300 pairs	Ancestry Informative Markers	Taqman	In process

Aim C.2.2: Related Pairs Research Repository

No funding was requested under this aim for the 0339 budget cycle.

Aim C.2.3 CIBMTR Integration

No funding was requested under this aim for the 0339 budget cycle.

II.D. Clinical Research in Transplantation – Hypothesis 1:

Clinical research in transplantation improves transplant outcomes and supports preparedness for a contingency response.

Aim D.1.1: Observational Research, Clinical Trials, and NIH Transplant Center

Resource for Clinical Investigations in Blood and Marrow Transplantation

During this grant, the Resource for Clinical Investigations in Blood and Marrow Transplantation (RCI BMT) developed its infrastructure further and made progress on a number of studies. The goal of this program is to provide an avenue for investigators to obtain statistical, study and data management support for prospective trials focusing on addressing various transplant issues. The following key elements were accomplished:

- The Clinical Trials Advisory Committee (CTAC), whose mission is to provide scientific review and recommendations on clinical trial proposals met a total of three times during this period. Twice in person (Tandem 2011 and 2012) and one conference call meeting during July 2012. A total of five study proposals were reviewed. Two were not recommended to proceed, one was recommended but the company decided to withdraw their proposal while the remaining two required additional information and a request to resubmit.

- Managed the Adult Double Cord in patients with hematologic malignancies trial. During this grant, accrual was met with a total of 56 patients enrolling. Staff continued to coordinate study activities, manage data and perform on site monitoring. A Tandem 2013 abstract was developed, submitted and accepted for oral presentation.[22] Initial work also began on analysis and writing of a full manuscript.

- During this grant period, the Lenalidomide after allogeneic HCT for Myeloma trial also met its accrual goal with 30 patients. Data management activities continued and a Tandem 2013 abstract was accepted for oral presentation.[23] In addition, further data analysis and writing of a full manuscript has begun.

- Staff supported the continued efforts related to the BMT CTN PBSC vs Marrow Phase III trial. This included managing the donor follow up component of the study and site monitoring at the donor centers. During this grant the Survey Research Group (SRG) acquired the five-year time point of the recipient quality of life and fully integrated this effort into their activities.

- The Long-term Donor Follow-up protocol continued to accrue donors both from the previous donated group and prospectively as donors participated in the standard work-up process. At the end of this grant period close to 10,000 donors were enrolled. The Survey Research Group is responsible for completing the follow up time points for the NMDP Operated Donor Centers. During this grant period they completed 5,629 follow up forms. As part of the project there was a plan to make a last outreach to those donors in the previously donated group who had not responded to the first three outreaches for consenting to the study. At the end of this grant period, 96% of the ~7000 in this group were contacted and 24% enrolled, 4% declined and the remaining were either unreachable or never responded. The SRG also absorbed into their process for following up on any reported events. This includes requesting a release of medical records from the donors, obtaining the records and preparing them for review by the Medical review team.

- As part of the CMS-MDS study accrual and data submission occurred during this grant period. Transplant Centers with a recipient enrolled on this study are required to submit the comprehensive research forms. A system is in place to only select a limited number of forms for general research purposes due to limited funds. The addition of these forms to the selection criteria does not replace but adds to the required forms. A total of 82 recipient CRF payments were covered during this period.

- During this grant period staff from the RCI BMT worked with CIT staff to complete operational requirements for a) comprehensive system for management of activities and studies within the Survey Research Group and b) clinical trial management system (CTMS) software to coordinate operational and administrative activities within RCI BMT.

Cord Blood Research Activity

During the project period, the Cord Blood Research subcommittee met semi-monthly to discuss study priorities and plan analyses for the following:

- The Duke and MD Anderson laboratory staff completed work on validating the assay methodologies but were unable to ensure consistent results generated at both testing sites for the study investigating biomarkers associated with cord blood engraftment. Initial and final statistical analysis of the validation testing results showed poor inter-laboratory reliability for all assays performed. Therefore, testing using a third laboratory was developed with St. Louis Cord Blood Bank (SLCBB) to determine whether the poor reliability is due to center-specific or assay related issues.

- The Duke and SLCBB created and finalized plans and testing for training and validating the assay methodologies. The data analysis for the results of the training phase met the acceptable threshold for the inter-laboratory reliability coefficient of variation (CV); however, the validation phase data analysis did not. An investigation into the cause of the poor reliability is on-going and does not involve further testing of samples.

- A white paper detailing recommendations/guidelines for the assessment of new assays (potency or other assays) relevant to cord blood banking and/or transplantation was published in . As a result, the NMDP was contacted by Hemogenix regarding a collaborative validation study for their potency assay (HALO). The proposal was reviewed by the Cord Blood Advisory Group (CBAG) and the Cord Research Subcommittee. The subsequent protocol was develop and reviewed and approved by the CBAG. Plans are in place to proceed with protocol development. Members of the CBAG expressed interest in the validation; however, upon solicitation of member banks for completion of the validation none could commit to the effort due to other priorities. The cord blood banks expressed a need to focus on FDA licensure efforts.

- The analysis evaluating the likelihood of finding a non-inherited maternal antigen/allele (NIMA) match for HLA mismatched cord blood unit for transplant when upfront maternal typing is not available was completed. The retrospective analysis compared the frequencies of the NIMA matched and mismatched HLA- A, B antigens or DRB1 alleles found in the Eurocord/NMDP/CIBMTR study to determine any significant differences. Results were incorporated into a manuscript which was published in Blood and Marrow Transplant Research.[25]

- Work began on a study to assess CBU characteristics (viability, TNC, CFU and CD34) pre-freeze and post thaw. Segment evaluation prior to unit release is under consideration as a third evaluation point, but will require an understanding of the release testing performed by the various CBBs. A survey was sent out to Network cord blood banks to collect data on cord blood release testing practices. Results of a survey to the cord blood banks were analyzed and the unit release testing data deemed too variable for meaningful analysis. The study will proceed with pre-freeze and post-thaw characteristics only. The study was discussed during the Cord Blood Advisory Group in May. A task force for study development was created and conference calls to discuss study development were conducted. The study design and proposal for submission to the CIBMTR was completed, submitted and accepted for presentation at the Graft Sources and Manipulation Working Committee at the BMT Tandem Meetings in 2013.

- Development of the anti-HLA donor specific antibody study of recipients transplanted with cord blood units was initiated. It was determined that the study cohort was too small to proceed with the study at that time.

- Work was initiated and completed on an assessment of the impact of donor inherited paternal antigen (IPA) disparity on outcomes after unrelated cord blood transplantation (UCBT) for acute lymphoblastic leukemia and acute myelogenous leukemia. Results were detailed in an abstract submitted and accepted for poster presentation at the 2012 International Cord Blood Symposium.

    - Colleen Brady, et al., Impact of donor inherited paternal antigen (IPA) disparity on outcomes after unrelated cord blood transplantation (UCBT for Acute Lymphoblastic Leukemia and Acute Myelogenous Leukemia. Poster presentation 2012 International Cord Blood Symposium.

- Two cord blood workshops were developed and conducted at the 2011 NMDP Council Meeting. Each workshop was well attended and received excellent ratings from the attendees.
    - New Research to Improve Cord Blood Transplant Outcomes: This workshop offered some of the cutting-edge work focused on improving cord blood outcomes by addressing some of the limitations of the graft source.
    - New Cord Blood Matching Concepts: This workshop provided recent findings on extended HLA matching (role of the HLA-C locus), matching for non-inherited maternal antigens, and the impact of pre-existing cord specific anti-HLA antibodies in cord blood transplant recipients.
- Two cord blood workshops were developed and conducted at the 2012 NMDP Council Meeting. Each workshop was well attended and received excellent ratings from the attendees.
    - Cord Blood Transplantation for Non-Malignant Disease: The workshop described the use of umbilical cord blood transplant (UCBT) for the treatment of nonmalignant diseases, specifically sickle cell anemia and hemoglobinopathies.
    - Unrelated Donor and CBU Selection Guidelines: This workshop presented updated selection guidelines from the NMDP and CIBMTR based on current and relevant data correlating graft characteristics with clinical transplant outcomes, on appropriated typing strategies and matching criteria for unrelated adult donor and cord blood graft selection.

NIH Search Support

The National Institutes of Health (NIH) has been accepted as an NMDP transplant center since 2007. Prior to that time, the NIH, representing our Nation's premier medical research endeavor, was not applying their considerable problem-solving skills to issues surrounding unrelated donor transplantation. The NMDP, with ONR support, set out to remedy that deficiency by entering into collaboration with NIH. This collaboration has been extremely successful.

The NMDP is collaborating with intramural NIH transplant programs from the NCI, the NHLBI and the NIAID. These programs are investigating alternative approaches in unrelated donor transplantation to improve patient outcomes. The actual transplants and the investigational portions of each transplant (i.e., the research protocols) are supported entirely with NIH funds. Navy funding supplies support for donor identification, selection, and collection. NMDP donors are not research subjects on these protocols because the donors are making standard donations for accepted transplant indications. The research component of these transplants is conducted entirely by NIH intramural program staff and funded entirely with NIH dollars. The NMDP provided support for the collection of 35 products (25 PBSC, 9 CBU, and 1 therapeutic T cell) under the grant.

CIBMTR Observational Research

Support of the Observational Research program included statistical hours for managing studies within the Immunobiology (see section IID1.3 below), GVHD, and Graft Sources Working Committees. During this grant period staff performed proposal review, protocol development, data preparation, data analysis, and manuscript preparations. Details regarding the Immunobiology activities can be found in IID1.3 below. The GVHD and Graft Sources Working Committees published 9 manuscripts.[26-34] During the grant period, staff performed various other functions on over 20 other studies.

CIBMTR IT Activity

During the project period, significant strides were made in improving user experience, delivering new functionality, improving data quality, data capture and data reporting through the CIBMTR IT suite of applications.

Audit

- Implementation of Donor Audit and Monitoring Functionality into FormsNet. This aids the audit team by providing the materials required to conduct on-site audits of Donor Centers (DC) to determine and document the error rate in the FormsNet2 database and identify systematic and non-systematic errors.

Prospective Studies

- A Sample Tracking Application in support of Clinical Trials was implemented into production in June 2011, along with the 1st clinical trial it supports. This application provides sample management/inventory tracking functionality for clinical trials. The associated Clinical Trial that was implemented was the 09-MRD (Minimal Residual Disease) Study. The new Form 2007 (Cord Blood) was also implemented into FormsNet.

- An additional release was completed to automate monitoring of a clinical trial. This functionality increased data quality and improved the efficiency in preparing data for analysis for Observational Studies.

Management Reporting Website

- Documented, produced, and released 35 new reports based on FormsNet data. This included clinic trials support, and management oversight of the Continuous Process Improvement Phase IV where centers must meet a 90% completed form submission and have a current IRB approved consent for research data.

NMDP Legacy Data

- Quality assurance of the mapping of NMDP legacy data (before 11/2007) to the FormsNet database was completed and migrated to FormsNet2.

Cord Blood/ Event Reporting

- This functionality was implemented in FormsNet to support the 10-CBA (Cord Blood Access) study and Event Reporting scope. This effort delivered components for enrollment, data collection of adverse events and product deviations (7 forms), tracking and reporting and medical monitoring. This project delivers functionality to meet the FDA requirements to collect and display Licensure status and IND information on CBUs by October 2011.

FormsNet3

- FormsNet3 was implemented after the funding period. However, the requirements documentation, extensive design and delivery of the technical infrastructure were a major focus of effort during the funding period.
- FormsNet3 Phase 1 – Recipient development remained on tract during this period and was undergoing full regression testing at the end of the funding period.

AGNIS & Metadata

- Through this period the AGNIS and metadata teams have enhanced their collaborative relationship with NCI by sharing tools developed by the AGNIS team with NCI for use of non-CIBMTR curation teams.
- Worked with NCI to integrate current CIBMTR context for hematopoietic cell transplantation (HCT) into future data model systems, such as Biomedical Research Integrated Domain Group (BRIDG). 1500 CIBMTR data points where approved.

EBMT

- European Group for Blood and Marrow Transplantation (EBMT)/ Eurocord Project. CIBMTR IT facilitated the connection of EBMT and Eurocord data submission to AGNIS. This exchange of data with European registries and cord blood banks is particularly beneficial to enhance cord blood outcomes data. Currently 48 centers are participating in production submission.

Center Activity

- There are 3 centers submitting to AGNIS without vendor support
- There are 12 centers certified to submit to AGNIS through vendor relationships
- There are 26 centers certified for retrieving data from AGNIS through vendor relationships

Forms supported

- Form2000 - Recipient Baseline Data
- Form2004 - Infectious Disease Markers
- Form2005 - Confirmation of HLA Typing
- Form 2006 – HSCT Infusion FormForm2018 - Hodgkin and Non-Hodgkin Lymphoma Pre-HSCT data
- Form2100 - 100 Days Post-HSCT Follow-up Form
- Form2118 - Hodgkin and Non-Hodgkin Lymphoma Post-HSCT data
- Form2200 - Six Months to Two Years Post-HSCT Data
- Form2300 - Yearly Follow-Up for Greater Than 2 Years Post-HSCT data
- Form2400 - Pre-Transplant Essential Data
- Form2450 - Post-Transplant Essential Data
- Form2451 - Chimerism Studies
- Form2455 - Selective Post-Transplant Essential Data
- Form 2804 – Unique ID form
- Form2900 - Recipient Death Data

Aim D.1.2: Research with NMDP Donors

No funding was requested under this aim for the 0339 budget cycle.

Aim D.1.3: Expand Immunobiology Research

During a previous grant period, the NMDP developed the Immunobiology Research grant request and award procedures for use by the IBWC and developed the IBWC Web site (://www.cibmtr.org/Studies/Immunobiology/Pages/index.). The content was updated on a regular basis during the grant period to highlight research activities, solicit new study proposals and feature the unique research resources (CIBMTR database, biostatistical expertise and NMDP Research Repository) available through the IBWC.

Grant funds supported significant outreach efforts by the IBWC leadership to increase exposure for the IBWC to researchers involved in immunobiology and immunogenetics. The IBWC leadership had a presence at the American Society of Hematology, BMT Tandem, European Group for Blood and Marrow Transplant, European Federation of Immunogenetics, and Cord Blood Symposium annual meetings.

In addition, the IBWC co-scientific director and biostatistician participated in the 16th International Histocompatibility Workshop in May 2012. The CIBMTR IBWC plays an integral role in the IHIW HCT component by supporting data and research sample sharing for all U.S. transplant centers that participate in the CIBMTR and NMDP Research Repository. The co-scientific director also serves on the IHIW-HCT steering committee.

Support permitted the IBWC to maintain a strong performance record with 6 abstracts accepted for presentation, 9 manuscripts published, and 1 manuscript submitted for publication. The IBWC reviewed 8 new proposals during the BMT Tandem meetings in February 2012 and accepted 6 for analysis. The IBWC leadership approved an immunobiology research grant to support the costs associated with the use of NMDP Research samples for study IB12-05: Plasma YKL-40 and CHI3L1 Genotype to Predict Mortality after Allogeneic Hematopoietic Cell Transplantation.

Nine manuscripts were published:

1. Spellman SR, Eapen M, Logan BR, Müller C, Rubinstein P, Setterholm MI, Woolfrey AE, Horowitz MM, Confer DL, Hurley CK. A perspective on the selection of unrelated donors and cord blood units for transplantation. Blood. 2012 Jul 12; 120(2):259-265. doi:10.1182/blood-2012-03-379032. Epub 2012 May 17. PMC3398760.

2. Battiwalla M, Wang T, Carreras J, Deeg HJ, Ayas M, Bajwa RPS, George B, Gupta V, Pasquini R, Schrezenmeier H, Passweg JR, Schultz KR, Eapen M. HLA-matched sibling transplantation for severe aplastic anemia: impact of HLA DR15 antigen status on engraftment, graft-versus-host disease, and overall survival. Biology of Blood and Marrow Transplantation: Journal of the American Society for Blood and Marrow Transplantation. 2012 Sep 1; 18(9):1401-1406. doi:10.1016/j.bbmt.2012.02.007. Epub 2012 Feb 28. PMC3406237.

3. Kamani NR, Walters MC, Carter S, Aquino V, Brochstein JA, Chaudhury S, Eapen M, Freed BM, Grimley M, Levine JE, Logan B, Moore T, Panepinto J, Parikh S, Pulsipher MA, Sande J, Schultz KR, Spellman S, Shenoy S. Unrelated donor cord blood transplantation for children with severe sickle cell disease: results of one cohort from the phase II study from the Blood and Marrow Transplant Clinical Trials Network (BMT CTN). Biology of Blood & Marrow Transplantation. 2012 Aug 1; 18(8):1265-1272. doi:10.1016/j.bbmt.2012.01.019. Epub 2012 Feb 16. PMC3618440.

4. Eapen M, Klein JP, Sanz GF, Spellman S, Ruggeri A, Anasetti C, Brown M, Champlin RE, Garcia-Lopez J, Hattersely G, Koegler G, Laughlin MJ, Michel G, Nabhan SK, Smith FO, Horowitz MM, Gluckman E, Rocha V. Effect of donor-recipient HLA matching at HLA A, B, C, and DRB1 on outcomes after umbilical-cord blood transplantation for leukaemia and myelodysplastic syndrome: a retrospective analysis. Lancet Oncology. 2011 Dec 1; 12(13):1214-1221. doi:10.1016/S1470-2045(11)70260-1. Epub 2011 Oct 6. PMC3245836.

5. Horan J, Wang T, Haagenson M, Spellman SR, Dehn J, Eapen M, Frangoul H, Gupta V, Hale GA, Hurley CK, Marino S, Oudshoorn M, Reddy V, Shaw P, Lee SJ, Woolfrey A. Evaluation of HLA matching in unrelated hematopoietic stem cell transplantation for nonmalignant disorders. Blood. 2012 Oct 4; 120(14):2918-2924. doi:10.1182/blood-2012-03-417758. Epub 2012 Jul 24. PMC3466972.

6. Petersdorf EW, Malkki M, Gooley TA, Spellman SR, Haagenson M, Horowitz MH, Wang T. MHC Resident Variation Affects Risks after Unrelated Donor Hematopoietic Cell Transplantation. Sci Transl Med. July 25; (144): 144ra101. : 10.1126/scitranslmed.3003974.

7. Venstrom JM, Pittari G, Gooley TA, Chewning JH, Spellman SR, HLA-C–Dependent Prevention of Leukemia Relapse by Donor Activating KIR2DS1. Submitted to New England Journal of Medicine. N Engl J Med. 2012 Aug 30;367(9):805-16. doi: 10.1056/NEJMoa1200503.

8. Rocha V, Spellman S, Zhang MJ, Ruggeri A, Purtill D, Brady C, Baxter-Lowe LA, Baudoux E, Bergamaschi P, Chow R, Freed B, Koegler G, Kurtzberg J, Larghero J, Lecchi L, Nagler A, Navarette C, Prasad V, Pouthier F, Price, T, Ratanatharathorn V, van Rood JJ, Horowitz MM, Gluckman E, Eapen M. Effect of HLA-matching recipients to donor noninherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy. Biol Blood Marrow Transplant:. 2012 Dec 1; 18(12):1890-1896. doi:10.1016/j.bbmt.2012.07.010. Epub 2012 Jul 17. PMC3826155.

9. Pittari G, Gooley TA, Chewning JH, Spellman S, Haagenson M, Gallagher MM, Malkki M, Petersdorf EW, DuPont B, Hsu KC. HLA-C-dependent prevention of leukemia

relapse by donor activating KIR2DS1. New England Journal of Medicine. 2012 Aug 30; 367(9):805-816. doi:10.1056/NEJMoa1200503. Epub 2012 May 1. PMC3767478.

One manuscript was submitted:

1. Sarah Cooley, et al., The protective effect of unrelated donors with killer-cell immunoglobulin-like recepto[r (KIR) B genes is enhanced in recipients with HLA-C1 group ligands. Submitted to Blood.

Six abstracts were accepted and presented:

1. Fabio Giglio, et al., KIR3DL1/S1 and HLA-B alleles combine to influence unrelated hematopoietic stem cell transplantation outcomes. Oral presentation 2012 BMT Tandem Meetings.

2. Carolyn Hurley, et al., Impact of unidirectional mismatches on the outcome of unrelated donor hematopoietic stem cell transplantation. Oral presentation 2012 IHIW/EFI/BSHI joint meetings.

3. Vanderson Rocha et al., Effect of HLA-matching recipient to donor non-inherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy. Presented at the 10th Annual Cord Blood Symposium, June 7-9, 2012, San Francisco.

4. Lawrence Petz, et al., The cure of HIV infections using cord blood transplantation. Submitted BBMT. Oral presentation 2012 BMT Tandem Meetings.

5. Carolyn Hurley, et al., Impact of unidirectional mismatches on the outcome of unrelated donor hematopoietic stem cell transplantation. Oral presentation 2012 IHIW/EFI joint meetings.

6. Minoo Battiwalla, et al., HLA DR15 antigen status does not impact graft-versus-host disease or disease-free survival in HLA-matched sibling transplantation for hematologic disease. Poster presentation 2011 ASH meeting

Attachment A – References

1. Kempenich JH, Dehn J, Setterholm M. Inaccuracy of HLA-DRB1*16:08. Tissue Antigens 2012; 79: Abstract P41.

2. Hollenbach JA, Madbouly A, Gragert L, et al. A combined DPA1~DPB1 amino acid epitope is the primary unit of selection on the HLA-DP heterodimer. Immunogenetics 2012; 64(8): 559-569.

3. Eberhard HP, Madbouly AS, Gourraud PA, et al. Comparative validation of computer programs for haplotype frequency estimation from donor registry data. Tissue Antigens 2013; 82(2): 93-105.

4. Maiers M, Gragert L, Madbouly A, et al. 16(th) IHIW: global analysis of registry HLA haplotypes from 20 million individuals: report from the IHIW Registry Diversity Group. Int J Immunogenet 2013; 40(1): 66-71.

5. Dehn J, Buck K, Yang SY, et al. 8/8 High-Resolution HLA Match Rate: The Impact of Race. Biol Blood Marrow Transplant 2011; 17(s2): S170-S171. Abstract O51.

6. Davis J, Buck K, Dorr L, et al. Evaluation of unrelated donor search strategy proficiency. Biol Blood Marrow Transplant 2006; 12:(s2); Abstract P79.

7. Malmberg CL, Davis J, Beduhn E, et al. Evaluation of transplant center unrelated donor search strategy proficiency. Biol Blood Marrow Transplant 2012; 18:(s2): Abstract S267.

8. Tram KV, Kempenich J, Dehn J. Considering HLA-C matching for single cord blood unit transplants. Human Immunol 2012; 73(s1): Abstract 122-P.

9. Dehn J, Maus M, Buck K, et al. A/B Only Typed Donors: Possible But Improbable 6/6 HLA Allele Matches. Biol Blood Marrow Transplant 2012; 18(s2): S270-271. Abstract P180.

10. Cooley S, Weisdorf DJ, Guethlein LA, et al. Donor selection for natural killer cell receptor genes leads to superior survival after unrelated transplantation for acute myelogenous leukemia. Blood 2010.

11. Cooley S, Trachtenberg E, Bergemann TL, et al. Donors with group B KIR haplotypes improve relapse-free survival after unrelated hematopoietic cell transplantation for acute myelogenous leukemia. Blood 2009; 113(3): 726-732.

12. McDermott DH, Conway SE, Wang T, et al. Donor and recipient chemokine receptor CCR5 genotype is associated with survival after bone marrow transplantation. Blood 2010; 115(11): 2311-2318.

13. Venstrom JM, Pittari G, Gooley TA, et al. HLA-C-dependent prevention of leukemia relapse by donor activating KIR2DS1. N Engl J Med 2012; 367(9): 805-816.

14. Petersdorf EW, Malkki M, Horowitz MM, et al. Mapping MHC haplotype effects in unrelated donor hematopoietic cell transplantation. Blood 2013; 121(10): 1896-1905.

15. Petersdorf EW, Malkki M, Gooley TA, et al. MHC-resident variation affects risks after unrelated donor hematopoietic cell transplantation. Sci Transl Med 2012; 4(144): 144ra101.

16. Spellman S, Warden MB, Haagenson M, et al. Effects of mismatching for minor histocompatibility antigens on clinical outcomes in HLA-matched, unrelated hematopoietic stem cell transplants. Biol Blood Marrow Transplant 2009; 15(7): 856-863.

17. Shamim Z, Spellman S, Haagenson M, et al. Polymorphism in the Interleukin-7 Receptor-alpha and Outcome after Allogeneic Hematopoietic Cell Transplantation with Matched Unrelated Donor. Scand J Immunol 2013; 78(2): 214-220.

18. Rocha V, Spellman S, Zhang MJ, et al. Effect of HLA-matching recipients to donor noninherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy. Biol Blood Marrow Transplant 2012; 18(12): 1890-1896.

19. Spellman S, Bray R, Rosen-Bronson S, et al. The detection of donor-directed, HLA-specific alloantibodies in recipients of unrelated hematopoietic cell transplantation is predictive of graft failure. Blood 2011; 115(13): 2704-2708.

20. Pearce KF, Lee SJ, Haagenson M, et al. Analysis of non-HLA genomic risk factors in HLA-matched unrelated donor hematopoietic cell transplantation for chronic myeloid leukemia. Haematologica 2012; 97(7): 1014-1019.

21. Shah R, Selby ST, Yokley B, et al. TNF, LTA and TGFB1 genotype distributions among acute graft-vs-host disease subsets after HLA-matched unrelated hematopoietic stem cell transplantation: a pilot study. Tissue Antigens 2009; 74(1): 50-56.

22. Barker JN, Fei M, Perez W, et al. Results of a Prospective Multi-Center Myeloablative Double-Unit Cord Blood Transplantation Trial in Adult Patients with Acute Leukemmia. Biol Blood Marrow Transplant 2013; 19(2s): S144-S145. Abstract O64.

23. Becker PS, Alsina M, Zhong X, et al. Phase I/II Multicenter Clinical Trial of Lenalidomide Maintenance After Allogeneic Hematopoietic Cell Transplant (alloHCT) in

Patients with High Risk (HR) Multiple Myeloma (MM). Biol Blood Marrow Transplant 2013; 19(2s): S154. Abstract 80.

24. Spellman S, Hurley CK, Brady C, Phillips-Johnson L, Chow R, Laughlin M, McMannis J, Reems JA, Regan D, Rubinstein P, Kurtzberg J. Guidelines for the development and validation of new potency assays for the evaluation of umbilical cord blood. Cytotherapy. 2011 Mar 30. [Epub ahead of print] PubMed PMID: 21449685.

25. Rocha V, Spellman S, Zhang MJ, et al. Effect of HLA-matching recipients to donor non-inherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy.. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.07.010. Epub 2012 JUL 16.

26. Ruggeri A, Eapen M, Scaravadavou A, et al. Umbilical cord blood transplantation for children with thalassemia and sickle cell disease. Biology of Blood and Marrow Transplantation: Journal of the American Society for Blood and Marrow Transplantation. 2011 Sep 1; 17(9):1375-1382. doi:10.1016/j.bbmt.2011.01.012. Epub 2011 Jan 28.

27. Arora M, Klein J, Weisdorf D, et a;. Chronic GVHD risk score: a Center for International Blood and Marrow Transplant Research analysis. Blood. 2011 Jun 14; 117(24):6714-6720. doi:10.1182/blood-2010-12-323824. Epub 2011 Apr 1.

28. Soiffer RJ, LeRademacher J, Ho V, et al. Impact of immune modulation with anti-T-cell antibodies on the outcome of reduced-intensity allogeneic hematopoietic stem cell transplantation for hematologic malignancies. Blood. 2011 Jun 1; 117(25):6963-6970. doi:10.1182/blood-2011-01-332007. Epub 2011 Apr 4.

29. Passweg JR, Zhang MJ, Rocha V, et al. Donor characteristics affecting graft failure, graft-versus-host disease, and survival after unrelated donor transplantation with reduced-intensity conditioning for hematologic malignancies. Biology of Blood & Marrow Transplantation. 2011 Nov 1; 17(12):1869-1873. doi:10.1016/j.bbmt.2011.07.008. Epub 2011 Jul 20.

30. Jacobsohn DA, Arora M, Klein JP, et al. Risk factors associated with increased nonrelapse mortality and with poor overall survival in children with chronic graft-versus-host disease. Blood. 2011 Oct 1; 118(16):4472-4479. doi:10.1182/blood-2011-04-349068. Epub 2011 Aug 30.

31. Eapen M, Klein JP, Sanz GF, et al. Effect of donor-recipient HLA matching at HLA A, B, C, and DRB1 on outcomes after umbilical-cord blood transplantation for leukaemia and myelodysplastic syndrome: a retrospective analysis. Lancet Oncology. 2011 Dec 1; 12(13):1214-1221. doi:10.1016/S1470-2045(11)70260-1. Epub 2011 Oct 6.

32. Jagasia MH, Arora M, Flowers ME, et al. Risk factors for acute GVHD and survival after hematopoietic cell transplantation. Blood. 2011 Dec 1; 119(1):296-307. doi:10.1182/blood-2011-06-364265. Epub 2011 Oct 18.

33. Battiwalla M, Ellis K, Li P, et al. HLA DR15 antigen status does not impact graft-versus-host disease or survival in HLA-matched sibling transplantation for hematologic malignancies. Biology of Blood & Marrow Transplantation. 2012 Aug 1; 18(8):1302-1308. doi:10.1016/j.bbmt.2012.02.011. Epub 2012 Mar 10.

34. Brunstein CG, Eapen M, Ahn KW, et al. Reduced-intensity conditioning transplantation in acute leukemia: the effect of source of unrelated donor stem cells on outcomes. Blood. 2012 Jun 7; 119(23):5591-5598. doi:10.1182/blood-2011-12-400630. Epub 2012 Apr 10.

Attachment B – Published Manuscripts and Abstracts Associated with this Grant

Manuscripts and Book Chapters

1. King RJ, Confer DL, Greinix HT, Halter J, Horowitz M, Schmidt AH, Costeas P, Shaw B, Egeland T. Unrelated hematopoietic stem cell donors as research subjects. Bone Marrow Transplantation 2011;46:10-13.

2. Uberti JP, Agovi M, Tarima S, Haagenson M, Gandham S, Anasetti C, Baker KS, Bolwell BJ, Bornhauser M, Chan KW, Copelan E, Davies SM, Finke J, Hale GA, Kollman C, McCarthy PL, Ratanatharathorn V, Ringdén O, Weisdorf DJ, Rizzo JD. Comparative analysis of Busulfan and Cyclophosphamide versus Cyclophosphamide and total body irradiation in full intensity unrelated marrow donor transplantation for acute myelogenous leukemia, chronic myelogenous leukemia and myelodysplasia. Bone Marrow Transplantation 2011; 46:34-43.

3. Uberti JP, Agovi M, Tarima S, Haagenson M, Gandham S, Anasetti C, Baker KS, Bolwell BJ, Bornhauser M, Chan KW, Copelan E, Davies SM, Finke J, Hale GA, Kollman C, McCarthy PL, Ratanatharathorn V, Ringdén O, Weisdorf DJ, Rizzo JD. Factors affecting mortality following myeloablative cord blood transplantation in adults: a pooled analysis of three international registries. Bone Marrow Transplantation 2011;46:70-76.

4. Majhail NS, Brazauskas R, Rizzo JD, Sobecks RM, Wang Z, Horowitz MM, Bolwell B, Wingard JR, Socie G. Secondary solid cancers after allogeneic hematopoietic cell transplantation using busulfan-cyclophosphamide conditioning. Blood 2011; 117:316-322.

5. Turbeville S, Nicely H, Rizzo JD, Pedersen TL, Orchard PJ, Horwitz ME, Horwitz EM, Veys P, Bonfim C, Al-Seraihy A. Clinical outcomes following hematopoietic stem cell transplantation for the treatment of mucopolysaccharidosis VI. Molecular Genetics and Metabolismt Metab 2011; 102:111-115.

6. Loren AW, Chow E, Jacobsohn DA, Gilleece M, Halter J, Joshi S, Wang Z, Sobocinski KA, Gupta V, Hale GA, Marks DI, Stadtmauer EA, Apperley J, Cahn JY, Schouten HC, Lazarus HM, Savani BN, McCarthy PL, Jakubowski AA, Kamani NR, Hayes-Lattin B, Maziarz RT, Warwick AB, Sorror ML, Bolwell BJ, Socié G, Wingard JR, Rizzo JD, Majhail NS. Pregnancy after hematopoietic cell transplantation: A Report from the Late

Effects Working Committee of the Center for International Blood and Marrow Transplant Research (CIBMTR). Biology of Blood and Marrow Transplantation 2011; 17:157-166.

7. Sabloff M, Chandy M, Wang Z, Logan BR, Ghavamzadeh A, Li CK, Irfan SM, Bredeson CN,Cowan MJ, Gale RP, Hale GA, Horan J, Hongeng S, Eapen M, Walters M. HLA-matched sibling Bone Marrow Transplantationation for β-Thalassemia major. Blood 2011; 117:1745-1750.

8. Horwitz EM, Horowitz MM, DiFronzo NL, Kohn DB, Heslop HE and for the BMT CTN State of the Science Cell and Gene Therapy Committee. Guidance for developing phase II cell therapy trial proposals for consideration by the Blood and Marrow Transplant Clinical Trials Network. Biology of Blood and Marrow Transplantation 2011; 17:192-196.

9. Pulsipher MA, Young NS, Tolar J, Risitano AM, Deeg HJ, Anderlini P, Calado R, Kojima S, Eapen M, Harris R, Scheinberg P, Savage S, Maciejewski JP, Tiu RV, DiFronzo N, Horowitz MM, Antin JH. Optimization of therapy for severe aplastic anemia based on clinical, biologic, and treatment response parameters: conclusions of an international working group on severe aplastic anemia convened by the Blood and Marrow Transplant Clinical Trials Network. Biology of Blood and Marrow Transplantation 2011; 17:291-299.

10. Horan J, Logan BR, Agovi M, Lazarus HM, Bacigalupo A, K Ballen K, Bredeson CN, Carabasi MH, Gupta V, Hale GA, Khoury HJ, JucketM, Litzow MR, Martino R, McCarthy PL, Smith FO, Rizzo JD, Pasquini MC. Reducing the risk for transplant related mortality after allogeneic hematopoietic cell transplantation: how much progress has been made? Journal of Clinical Oncology 2011; 29:805-813.

11. Madureira AB, Eapen M, Locatelli F, Teira P, Zhang MJ, Davies SM, Picardi A, Woolfrey A, Chan KW, Socié G, Vora A, Bertrand Y, Sales-Bonfim CM, Gluckman E, Niemeyer C, Rocha V. Analysis of risk factors influencing outcome in children with myelodysplastic syndrome after unrelated cord blood transplantation. Leukemia 2011; 25:449-454.

12. Majhail, NS, Bajorunaite R, Lazarus HM, Wang Z, Klein JP, Zhang M-J, Rizzo JD. High probability of long-term survival in 2-year survivors of autologous hematopoietic cell transplantation for AML in first or second CR. Bone Marrow Transplantation 2011; 46:385–392.

13. Bochtler W, Maiers M, Bakker JNA, Oudshoorn M, Marsh SGE, Baier D, Hurley CK, Müller CR. World Marrow Donor Association framework for the implementation of HLA matching programs in hematopoietic stem cell donor registries and cord blood banks. Bone Marrow Transplantation 2011; 46:338-343.

14. Logan BR, Zhang MJ, Klein JP. Marginal models for clustered time-to-event data with competing risks using pseudovalues. Biometrics 2011; 67:1-7.

15. Klein JP and Tunes da Silva G. Cutpoint selection for discretizing a continuous covariate for generalized estimating equations. Computational Statistics & Data Analysis 2011; 55(1):226-235.

16. Grossberg S, Ogar J, Grossberg L, Gehsam A, Klein JP. Frequency and magnitude of interferon β neutralizing antibodies in the evaluation of interferon β immunogenicity in multiple sclerosis patients. Journal of Interferon and Cytokine Research 2011; 31 (3):337-44.

17. Valcárcel D, Sierra J, Wang T, Kan F, Gupta V, Hale GA, Marks D, McCarthy PL, Oudshoorn M, Petersdorf EW, Ringdén O, Setterholm M, Spellman SR, Waller EK, Gajewski JL, Marino SR, Senitzer D, Lee, SJ. One antigen mismatched related vs. HLA-matched unrelated donor hematopoietic transplantation in adults with acute leukemia: CIBMTR results in the era of molecular HLA typing. Biology of Blood and Marrow Transplantation 2011; 17(5):640-8.

18. Pollack M, Heugel J, Xie H, Leisenring W, Storek J, Young JA, Kukreja M, Gress R, Tomblyn M, Boeckh M. An international comparison of current strategies to prevent herpesvirus and fungal infections in hematopoietic cell transplant recipients. Biology of Blood and Marrow Transplantation 2011; 17:664-673.

19. Woodard P, Carpenter PA, Davies SM, Gross TG, He W, Zhang MJ, Horn BN, Margolis DA, Perentesis JP, Sanders JE, Schultz KR, Seber A, Woods WG, Eapen M. Unrelated donor Bone Marrow Transplantationation for myelodysplastic syndrome in children. Biology of Blood and Marrow Transplantation 2011; 17:723-728.

20. Barker CC, Agovi MA, Logan BR, Lazarus HM, Ballen KK, Gupta V, Hale GA, Frangoul H, Ho VT, Rizzo JD, Pasquini MC, on behalf of the Regimen Related Toxicity Writing Committee, CIBMTR. Childhood obesity and outcomes after Bone Marrow Transplantationation for patients with severe aplastic anemia. Biology of Blood and Marrow Transplantation 2011; 17:737-744.

21. Wingard JR, Majhail NS, Brazauskas R, Wang Z, Sobocinski KA, Jacobsohn D, Sorror ML, Horowitz MM, Bolwell B, Rizzo JD, Socié G. Long-term survival and late deaths after allogeneic hematopoietic cell transplantation. Journal of Clinical Oncology 2011; 29(16): 2230-9.

22. Woolfrey A, Klein JP, Haagenson M, Spellman S, Petersorf EW, Oudshoorn M, Gajewski J, Hale GA, Horan J, Battiwalla M, Marino SR, Setterholm M, Ringdén O, Hurley C, Flomenberg N, Anasetti C, Fernandez-Vina M, Lee SJ. HLA-C antigen

mismatches are associated with worse outcomes in unrelated donor peripheral blood stem cell transplantation. Biology of Blood and Marrow Transplantation 2011; 17(6): 885-892.

23. Chu R, Brazauskas R, Kan F, Bashey A, Bredeson C, Camitta B, Chiang KY, Frangoul H, Gale RP, Gee A, George B, Goldman FD, Gross TG, Gupta V, Hale GA, Isola L, Ispizua AU, Lazarus H, Marsh J, Russell J, Sabloff M, Waller EK, Eapen M. Comparison of outcomes after transplantation of G-CSF stimulated bone marrow grafts versus bone marrow or peripheral blood grafts from HLA-matched sibling donors for patients with severe aplastic anemia. Biology of Blood and Marrow Transplantation 2011; 17(7): 1018-1024.

24. Tomblyn MR, Ewell M, Bredeson C, Kahl BS, Goodman SA, Horowitz MM, Vose JM, Negrin RS, Laport GG. Autologous vs. reduced intensity allogeneic hematopoietic cell transplantation for patients with chemosensitive follicular non-Hodgkin's lymphoma beyond first complete response or first partial response biology of blood and marrow transplantation. Biology of Blood and Marrow Transplantation 2011; 17(7): 1051-1057.

25. Majhail NS, Murphy EA, Omondi NA, Robinett P, Gajewski JL, LeMaistre CF, Confer D, Rizzo JD. Allogeneic transplant physician and center capacity in the United States. Biology of Blood and Marrow Transplantation 2011; 17(7): 956-961.

26. Dong L, Wu T, Gao ZY, Zhang MJ, Kan F, Spellman SR, Tan XY, Zhao YL, Wang JB, Lu DP, Miklos D, Petersdorf E, Fernandez-Vina M, Lee SJ. The outcomes of family haploidentical hematopoietic stem cell transplantation in hematologic malignancies are not associated with patient age. Biology of Blood and Marrow Transplantation. Published online December 29, 2011; doi:10.1016/j.bbmt.2010.12.703.

27. Marino SR, Lin S, Maiers M, Haagenson M, Spellman S, Klein JP, Binkowski TA, Lee SJ, van Besien K. Identification by random forest method of HLA class I amino acid substitutions associated with lower survival at day 100 in unrelated donor hematopoietic cell transplantation. Bone Marrow Transplantation. Published online March 28, 2011; doi: 10.1038/bmt.2011.56.

28. Devine SM, Carter S, Soiffer RJ, Pasquini MC, Hari PN, Stein A, Lazarus HM, Linker C, Stadtmauer EA, Alyea EP 3rd, Keever-Taylor CA, O'Reilly RJ. Low risk of chronic graft versus host disease and relapse associated with t-cell depleted peripheral blood stem cell transplantation for acute myeloid leukemia in first remission: results of the Blood and Marrow Transplant Clinical Trials Network (BMT CTN) Protocol 0303. Biology of Blood and Marrow Transplantation. Published online February 14, 2011; doi:10.1016/j.bbmt.2011.02.002.

29. Luger SM, Ringdén O, Zhang M-J, Pérez WS, Bishop MR, Bornhauser M, Bredeson CN, Cairo MS, Copelan EA, Gale RP, Giralt SA, Gulbas Z, Gupta V, Hale GA, Lazarus HM, Lewis VA, Lill MC, McCarthy PL, Weisdorf DJ, Pulsipher MA. Similar outcomes using

myeloablative vs reduced intensity allogeneic transplant preparative regimens for AML or MDS. Bone Marrow Transplantation. Published online March 28, 2011; doi: 10.1038/bmt.2011.69.

30. Spellman S, Hurley CK, Brady C, Phillips-Johnson L, Barker J, Chow R, Laughlin M, McMannis J, Reems J-A, Regan D, Rubinstein P, Kurtzberg J. Guidelines for development and validation of new potency assays for the evaluation of umbilical cord blood. Cytotherapy. Published online March 30, 2011.

31. Arora M, Klein J Weisdorf D; Hassebroek A, Flowers MED Cutler CS, Urbano-Ispizua A, Antin J, Bolwell B, Boyiadzis M, Cahn J-Y, Cairo M, Isola L, Jacobsohn DA, Jagasia M, Klumpp T, Lee S, Petersdorf EW, Gale RP Schouten H, Spellman S, John Wingard J, Horowitz M, Pavletic SZ. Chronic GVHD risk score: a Center for International Blood and Marrow Transplant Research analysis. Blood. Published online April 14, 2011; doi:10.1182/blood-2010-12-323824.

32. Ahmed SO, Ghavamzadeh A, Zaidi S, Baldomero H, Pasquini M, Hussain F, Alimoghaddam K, Almohareb F, Ayas M, Hamidieh A, Mahmoud H, Elhaddad A, Ben Othman T, Abdelkefi A, Sarhan M, Abdel-Rahman F, Adil S, Alkindi S, Bazarbachi A, Benchekroun S, Niederwieser D, Horowitz M, Gratwohl A, El Solh H, Aljurf M. Trends of Hematopoietic Stem Cell Transplantation in the Eastern Mediterranean Region, 1984-2007. Biology of Blood and Marrow Transplantation. Published online March 28, 2011; doi:10.1016/j.bbmt.2011.01.019.

33. Nemecek ER, Ellis K, He W, Bunin NJ, Bajwa RS, Cheerva A, Cairo MS, Dvorak C, Duval M, Davies S, Eapen M, Gross TG, Hussein AA, MacMillan ML, Mehta PA, Pulsipher MA, Seber A, Woolfrey AE, Frangoul HA, Carpenter PA. Outcome of myeloablative conditioning and unrelated donor hematopoietic cell transplantation for childhood acute lymphoblastic leukemia in third remission. Biology of Blood & Marrow Transplantation. 17:1833-1840. Epub 2011 May 27. 2011 Nov 1;

34. Kamani NR, Kumar S, Hassebroek A, Eapen M, LeRademacher J, Casper J, Cowan M, Sánchez de Toledo J, Ferster A, Szabolcs P, Wingard JR, Horwitz E, Filipovich AH. Malignancies after hematopoietic cell transplantation for primary immune deficiencies: A report from the CIBMTR. Biology of Blood & Marrow Transplantation. 17:1783-1789. Epub 2011 May 20. 2011 Nov 1;

35. Vogl DT, Wang T, Pérez WS, Stadtmauer EA, Heitjan DF, Lazarus HM, Kyle RA, Kamble R, Weisdorf D, Gibson J, Ballen K, Holmberg L, Bashey A, McCarthy PL, Freytes C, Maharaj D, Maiolino A, Vesole DH, Hari P. Effect of obesity on outcomes after autologous hematopoietic stem cell transplantation for multiple myeloma Biology of Blood & Marrow Transplantation. 17:1765-1774. Epub 2011 May 11. 2011 Nov 1;

36. Farag SS, Maharry K, Zhang MJ, Pérez WS, George SL, Mrózek K, DiPersio J, Bunjes DW, Marcucci G, Baer MR, Cairo M, Copelan E, Cutler CS, Isola L, Lazarus HM, Litzow MR, Marks DI, Ringdén O, Rizzieri DA, Soiffer R, Larson RA, Tallman MS, Bloomfield CD, Weisdorf DJ. Comparison of reduced-intensity allogeneic hematopoietic cell transplantation with chemotherapy in patients aged 60-70 years with acute myeloid leukemia in first remission: a center for international blood and marrow transplant research and cancer and leukemia group b study. Biology of Blood & Marrow Transplantation. 17:1796-1803. Epub 2011 Jun 21. 2011 Nov 1;

37. Kumar S, Zhang MJ, Li P, Dispenzieri A, Milone GA, Lonial S, Krishnan A, Maiolino A, Wirk B, Weiss B, Freytes CO, Vogl DT, Vesole DH, Lazarus HM, Meehan KR, Hamadani M, Lill M, Callander NS, Majhail NS, Wiernik PH, Nath R, Kamble RT, Vij R, Kyle RA, Gale RP, Hari P. Trends in allogeneic stem cell transplantation for multiple myeloma: a Center for International Blood and Marrow Transplant Research (CIBMTR) analysis Blood. 118(7):1979-88. Epub 2011 Jun 20. 2011 Aug 18;

38. Soiffer RJ, LeRademacher J, Ho V, Kan F, Artz A, Champlin RE, Devine S, Isola L, Lazarus HM, Marks DI, Porter DL, Waller EK, Horowitz MM, Eapen M. Impact of immune modulation with anti-T cell antibodies on the outcome of reduced intensity allogeneic hematopoietic stem cell transplantation for hematologic malignancies. Blood. 117:6963-6970. Epub 2011 Apr 4. 2011 Jun 1;

39. Passweg JR, Zhang MJ, Rocha V, Kan F, Champlin RE, Isola LM, Gee AP, Gibson J, Laughlin MJ, Lazarus HM, Loren A, Marks D, Gratwohl A, Eapen M. Donor characteristics affecting graft failure and survival after unrelated donor transplantation with reduced intensity conditioning for hematologic malignancies. Biology of Blood & Marrow Transplantation. 17:1869-1873. Epub 2011 Jul 20. 2011 Nov 1;

40. Armand P, Kim HT, Zhang MJ, Perez WS, Dal Cin PS, Klumpp TR, Waller EK, Litzow MR, Liesveld JL, Lazarus HM, Artz AS, Gupta V, Savani BN, McCarthy PL, Cahn J-Y, Schouten HC, Finke J, Ball ED, Aljurf MD, Cutler CS, Rowe JM, Antin JH, Isola LM, Di Bartolomeo P, Camitta BM, Miller AM, Cairo MS, Stockerl-Goldstein K, Sierra J, Savoie ML, Halter J, Stiff PJ, Nabhan C, Jakubowski AA, Bunjes DW, Petersdorf EW, Devine SM, Maziarz RT, Bornhauser M, Lewis VA, Marks DI, Bredeson CN, Soiffer RJ, Weisdorf DJ. Classifying cytogenetics in patients with aml in complete remission undergoing allogeneic transplantation: a CIBMTR study. Biology of Blood & Marrow Transplantation. 18(2):280-8. Epub 2011 Jul 31. 2012 Feb 1; doi:10.1182/blood-2011-2011-06-364265.

41. Howard D, Kenline C, Lazarus HM, LeMaistre CF, Maziarz RT, McCarthy PL, Parsons S, Szwajcer D, Rizzo JD, Majhail NS. Abandonment of high-dose chemotherapy/hematopoietic cell transplants for breast cancer following negative trial results. Health Services Research. 46:1762-1777. Epub 2011 Jul 1. 2011 Dec 1; doi: 10.1111/j.1475-6773.2011.01296.x.

42. Brunstein CG, Fuchs EJ, Carter SL, Karanes C, Costa LJ, Wu J, Devine SM, Wingard JR, Aljitawi OS, Cutler CS, Jagasia MH, Ballen KK, Eapen M, O'Donnell PV. Alternative donor transplantation: results of parallel phase II trials using HLA-mismatched related bone marrow or unrelated umbilical cord blood grafts. Blood. 118:282-288. Epub 2011 Apr 28. 2011 Jul 1;

43. Jacobsohn DA, Arora M, Klein JP, Hassebroek A, Flowers ME, Cutler CS, Urbano-Ispizua A, Bolwell BJ, Antin JH, Boyiadzis M, Cahn JY, Cairo MC, Herzig RH, Isola LM, Klumpp TR, Lee SJ, Petersdorf EW, Santarone S, Gale RP, Schouten HC, Spellman SR, Weisdorf DJ, Wingard JR, Horowitz MM, Pavletic SZ. Risk factors associated with increased non-relapse mortality and with poor overall survival in children with chronic graft-versus-host disease. Blood. 118:4472-4479. Epub 2011 Aug 30. 2011 Oct 1;

44. Illei GG, Cervera R, Doria A, Hiepe F, Jayne D, Pavletic S, Martin T, Marmont A, Saccardi R, Voskuyl AE, Farge D. Current state and future directions of autologous hematopoietic stem cell transplantation in systemic lupus erythematosus. Annals of the Rheumatic Diseases. 70:2071-2074. Epub 2011 Aug 26. 2011 Dec 1; doi:10.1136/ard.2010.148049.

45. Krishnan A, Pasquini MC, Logan B, Stadtmauer EA, Vesole DH, Alyea EP III, Antin JH, Comenzo R, Goodman S, Hari P, Laport GG, Qazilbash MH, Rowley S, Sahebi F, Somlo G, Vogl DT, Weisdorf D, Ewell M, Wu J, Geller NL, Horowitz MM, Giralt S, Maloney DG. Autologous haemopoietic stem-cell transplantation followed by allogeneic or autologous haemopoietic stem-cell transplantation in patients with multiple myeloma (BMT CTN 0102): a phase 3 biological assignment trial. Lancet Oncology. 12:1195-1203. Epub 2011 Sep 29. 2011 Dec 1;

46. Spellman SR, Klein JP, Haagenson MD, Askar M, Baxter-Lowe LA, He J, Hsu S, Blasczyk R, Hurley CK. Scoring HLA Class I Mismatches by HistoCheck Does Not Predict Clinical Outcome in Unrelated Hematopoietic Stem Cell Transplantation Biology of Blood and Marrow Transplantation. Biology of Blood & Marrow Transplantation. Epub 2011 Sep 29. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.

47. Ringdén O, Shrestha S, Tunes da Silva G, Zhang MJ, Dispenzieri A, Remberger M, Kamble RT, Freytes CO, Gale RP, Gibson J, Gupta V, Holmberg LA, Lazarus HM, McCarthy PL, Meehan KR, Schouten HC, Milone GA, Lonial S, Hari PN. Effect of acute and chronic GVHD on relapse and survival after reduced-intensity conditioning allogeneic transplantation for myeloma Bone Marrow Transplantation. Epub 2011 Sep 26. [Epub ahead of print]; doi: 10.1038/bmt.2011.192.

48. Majhail NS, Brazauskas R, Hassebroek A, Bredeson CN, Hahn T, Hale GA, Horowitz MM, Lazarus HM, Maziarz RT, Wood WA, Parsons SK, Joffe S, Rizzo JD, Lee SJ, Hayes-Lattin BM. Outcomes of allogeneic hematopoietic cell transplantation for

adolescent and young adults compared to children and older adults with acute myeloid leukemia Biology of Blood & Marrow Transplantation. Epub 2011 Oct 29. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.10.031.

49. Jagasia MH, Arora M, Flowers ME, Chao NJ, McCarthy PL, Cutler CS, Urbano-Ispizua A, Pavletic SZ, Haagenson MD, Zhang MJ, Antin JH, Bolwell BJ, Bredeson CN, Cahn JY, Cairo MS, Gale RP, Gupta V, Lee SJ, Litzow MR, Weisdorf DJ, Horowitz MM, Hahn T. Risk factors for acute GvHD and survival after hematopoietic cell transplantation. Blood. 119(1):296-307. Epub 2011 Oct 18. 2011 Dec 1; doi:10.1182/blood-2011-2011-06-364265.

50. Khoury HJ, Kukreja M, Goldman JM, Wang T, Halter J, Arora M, Gupta V, Rizzieri DA, George B, Keating A, Gale RP, Marks DI, McCarthy PL, Woolfrey A, Szer J, Giralt SA, Maziarz RT, Cortes J, Horowitz MM, Lee SJ. Prognostic factors for outcomes in allogeneic transplantation for CML in the imatinib era: a CIBMTR analysis. Bone Marrow Transplantation. Epub 2011 Oct 10. [Epub ahead of print]; doi:10.1038/bmt.2011.194.

51. Eapen M, Klein JP, Sanz GF, Spellman S, Ruggeri A, Anasetti C, Brown M, Champlin RE, Garcia-Lopez J, Hattersely G, Koegler G, Laughlin MJ, Michel G, Nabhan SK, Smith FO, Horowitz MM, Gluckman E, Rocha V. Effect of donor-recipient HLA matching at HLA A, B, C, and DRB1 on outcomes after umbilical-cord blood transplantation for leukaemia and myelodysplastic syndrome: a retrospective analysis. Lancet Oncology. 12:1214-1221. Epub 2011 Oct 6. 2011 Dec 1;

52. Majhail NS, Murphy EA, Denzen EM, Ferguson SS, Anasetti C, Bracey A, Burns L, Champlin R, Hubbard N, Maziarz RT, Medoff E, Neumann J, Weisdorf DJ, Yolin Raley DS, Chell J, Snyder EL. The National Marrow Donor Program's Symposium on hematopoietic cell transplantation in 2020: a health care resource and infrastructure assessment. Biology of Blood & Marrow Transplantation. 18:172-182. Epub 2011 Oct 1. 2012 Feb 12; doi:10.1016/j.bbmt.2011.10.004.

53. Ballen KK, Klein JP, Pedersen TL, Bhatla D, Duerst RE, Kurtzberg J, Lazarus HM, LeMaistre CF, McCarthy PL, Mehta P, Palmer J, Setterholm M, Wingard JR, Joffe S, Parsons SK, Switzer GE, Lee SJ, Rizzo JD, Majhail NS. Relationship of race/ethnicity and survival after single umbilical cord blood transplantation for adults and children with leukemia and myelodysplastic syndromes. Biology of Blood & Marrow Transplantation. Epub 2011 Nov 4. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.10.040.

54. Mahindra A, Kalaycio ME, Vela-Ojeda J, Vesole DH, Zhang MJ, Li P, Berenson JR, Bird JM, Gajewski JL, Gale RP, Holmberg L, Kumar S, Kyle RA, Lazarus HM, Lonial S, Mikhael J, Milone GA, Munker R, Nath R, Saccaro S, To LB, Vogl DT, Wirk B, Hari P. Hematopoietic cell transplantation for primary plasma cell leukemia: results from the

Center for International Blood and Marrow Transplant Registry. Leukemia. Epub 2011 Nov 1. [Epub ahead of print]; doi:10.1038/leu.2011.312.

55. Freytes CO, Zhang MJ, Carreras J, Burns LJ, Gale RP, Isola L, Perales MA, Seftel M, Vose JM, Miller AM, Gibson J, Gross TG, Rowlings PA, Inwards DJ, Pavlovsky S, Martino R, Marks DI, Hale GA, Smith SM, Schouten HC, Slavin S, Klumpp TR, Lazarus HM, Van Besien K, Hari PN. Outcome of lower-intensity allogeneic transplantation in non-Hodgkin lymphoma after autologous transplant failure. Biology of Blood & Marrow Transplantation. Epub 2011 Dec 23. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.12.581.

56. Tomblyn MR, Kukreja M, Tarima S, Aljurf MD, Al Mohareb FI, Bolwell BJ, Cahn JY, Carabasi MH, Gale RP, Gress RE, Gupta V, Hale GA, Ljungman P, Maziarz RT, Storek J, Wingard JR, Young JH, Horowitz MM, Ballen KK. No increased mortality from donor or recipient hepatitis B and/or hepatitis C positive serostatus after related donor allogeneic hematopoietic cell transplantation. Transplant Infectious Disease. [Epub ahead of print] doi: 10.1111/j.1399-3062.2012.00732.x. Epub 2012 MAY 01.

57. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended screening and preventive practices for long-term survivors after hematopoietic cell transplantation Biology of Blood & Marrow Transplantation. 18:348-371. Epub 2011 Dec 13. 2012 Mar 1; doi.org/10.1016/j.bbmt.2011.12.519.

58. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Hematology-Oncology and Stem Cell Therapy. 2012 JAN 01; doi:10.5144/1658-3876.2012.1. 5:1-30.

59. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Revista Brasileira de Hematologia e Hemoterapia. 2012 MAR 01; http://dx.doi.org/10.5581/1516-8484.20120032. 34(2): 109-133.

60. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Bone Marrow Transplantation. 2012 MAR 01; doi:10.1038/bmt.1012.5. 47:337-341.

61. Weisdorf D, Cooley S, Devine S, Fehninger T, DiPersio J, Anasetti C, Waller E, Porter D, Farag S, Drobyski W, Defor T, Curtsinger J, Miller J. T cell-depleted partial matched

unrelated donor transplant for advanced myeloid malignancy: KIR ligand mismatch and outcome. Biology of Blood & Marrow Transplantation. Epub 2011 Dec 7. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.11.024.

62. Hale GA, Shrestha S, Le Rademacher J, Burns LJ, Gibson J, Inwards DJ, Freytes CO, Bolwell BJ, Hsu JW, Slavin S, Isola L, Rizzieri DA, Gale RP, Laport GG, Montoto S, Lazarus HM, Hari PN. Alternate donor hematopoietic cell transplantation (HCT) using reduced-intensity conditioning regimens in non-Hodgkins lymphoma: a report from the CIBMTR Biology of Blood & Marrow Transplantation. Epub 2011 Dec 7. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.11.026.

63. Eapen M, Horowitz MM. Alternative donor transplantation for aplastic anemia. American Society of Hematology, Education Program Book. 43-46. 2011 Dec 1;

64. Majhail NS, Nayyar S, Burton Santibanez ME, Murphy EA, Denzen EM. Racial disparities in hematopoitic cell transplantation in the United States. Bone Marrow Transplantation. [Epub ahead of print] doi: 10.1038/bmt.2011.214. Epub 2011 NOV 07.

65. Yanover C, Petersdorf EW, Malkki M, Gooley T, Spellman S, Velardi A, Bardy P, Madrigal A, Bignon JD, Bradley P. HLA mismatches and hematopoietic cell transplantation: Structural simulations assess the impact of changes in peptide binding specificity on transplant outcome. Immunome Research. 2011 NOV 20; 7(2):4.

66. Pearce KF, Lee SJ, Haagenson M, Petersdorf EW, Norden J, Collin MP, Klein JP, Spellman SR, Lowerson SA, Davies SM, Dickinson AM. Analysis of non-HLA genomic risk factors in HLA-matched unrelated donor hematopoietic cell transplantation for chronic myeloid leukemia. Haematologica. [Epub ahead of print] doi:10.3324/haematol.2011.053611. Epub 2012 JAN 22.

67. Battiwalla M, Wang T, Carreras J, Deeg HJ, Ayas M, Bajwa RPS, George B, Gupta V, Pasquini R, Schrezenmeier H, Passweg JR, Schultz KR, Eapen M. HLA-matched sibling transplantation for severe Aplastic anemia: impact of HLA DR15 antigen status on engraftment, graft vs. host disease and overall survival. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.02.007. Epub 2012 FEB 28.

68. Fleischhauer K, Shaw BE, Gooley T, Malkki M, Bignon JD, Dubois V, Horowitz MM, Madrigal JA, Morishima Y, Oudshoorn M, Ringdén O, Spellman S, Velardi A, Zino E, Petersdorf EW. Effect of T-cell-epitope matching at HLA-DPB1 in recipients of unrelated-donor haemopoietic-cell transplantation: a retrospective study. Lancet Oncology. 2012 APR 01; doi:10.1016/S1470-2045(12)70071-2. 13(4):366-374. Epub 2012 FEB 15.

69. Kamani NR, Walters MC, Aquino V, Brochstein JA, Chaudhury S, Eapen M, Freed BM, Grimley M, Levine JE, Logan B, Moore T, Panepinto J, Parikh S, Pulsipher MA, Sande J, Schultz KR, Spellman S, Shenoy S. Unrelated donor cord blood transplantation for children with severe sickle cell disease: results of one cohort from the Phase II study from the Blood and Marrow Transplant Clinical Trials Network (BMT CTN). Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.01.019. Epub 2012 FEB 16.

70. Saber W, Opie S, Rizzo JD, Zhang MJ, Horowitz MM, Schriber J. Outcomes after matched unrelated donor vs. identical sibling hematopoietic cell transplantation (HCT) in adults with acute myelogenous leukemia (AML). Blood. 2012 APR 26; doi:10.1182/blood-2011-09-381699. 119:3908-3916. Epub 2012 FEB 10. [Available on 2013/4/26]

71. Ballen KK, Woolfrey AE, Zhu X, Ahn KW, Wirk B, Arora M, George B, Savani BN, Bolwell B, Porter DL, Copelan E, Hale G, Schouten HC, Lewis I, Cahn JY, Halter J, Cortes J, Kalaycio ME, Antin J, Aljurf MD, Carabasi MH, Hamadan M, McCarthy P, Pavletic S, Gupta V, Maziarz RT, Horowitz MM, Saber W. Allogeneic hematopoietic cell transplantation for advanced polycythemia vera and essential thrombocythemia.. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.03.009. Epub 2012 MAR 23.

72. Battiwalla M, Ellis K, Li P, Pavletic SZ, Akpek G, Hematti P, Klumpp TR, Maziarz RT, Savani B, Aljurf MD, Cairo MS, Drobyski WR, George B, Hahn T, Khera N, Litzow MR, Loren AW, Saber W, Arora M, Urbano-Ispizua A, Cutler C, Flowers MED, Spellman SR. HLA DR15 antigen status does not impact graft-versus-host disease or survival in HLA-matched sibling transplantation for hematologic malignancies. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.02.011. Epub 2012 MAR 10.

73. Eapen M, Ahn KW, Orchard PJ, Cowan MJ, Davies SM, Fasth A, Hassebroek A, Ayas M, Bonfim C, O'Brien TA, Gross TG, Horwitz M, Horwitz E, Kapoor N, Kurtzberg J, Majhail N, Ringdén O, Szabolcs P, Veys P, Baker KS. Long-term survival and late deaths after hematopoietic cell transplantation for primary immunodeficiency diseases and inborn errors of metabolism. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.03.003. Epub 2012 MAR 16.

74. Levine JE, Logan BR, Wu J, Alousi AM, Bolaños-Meade J, Ferrara JLM, Ho VT, Weisdorf DJ, Paczesny S. Acute graft-versus-host disease biomarkers measured during therapy can predict treatment outcomes: a Blood and Marrow Transplant Clinical Trials Network study. Blood. 2012 APR 19; doi:10.1182/blood-2012-01-403063. 119(16):3854-60. Epub 2012 MAR 01.

75. Saccardi R, Freedman MS, Sormani MP, Atkins H, Farge D, Griffith LM, Kraft G, Mancardi GL, Nash R, Pasquini M, Martin R, Muraro P. A prospective, randomized, controlled trial of autologous haematopoietic stem cell transplantation for aggressive multiple sclerosis: a position paper. Multiple Sclerosis Journal. [Epub ahead of print] doi:10.1177/1352458512438454. Epub 2012 MAR 20.

76. Thiel EL, Zhang MJ, Davies SM, Camitta BM, Logan B, Tiedemann K, Eapen M. Comparison of outcomes after HLA-matched sibling and unrelated donor transplantation for children with high-risk acute lymphoblastic leukemia. Blood. [Epub ahead of print] doi:10.1016/j.bbmt.2012.01.007. Epub 2012 MAR 06.

77. Brunstein CG, Eapen M, Ahn KW, Appelbaum FR, Ballen KK, Champlin RE, Cutler C, Kan F, Laughlin MJ, Soiffer RJ, Weisdorf DJ, Woolfrey A, Wagner JE. Reduced intensity conditioning transplantation in acute leukemia: the effect of source of unrelated donor stem cells on outcomes. Blood. 2012 JUN 07; doi:10.1182/blood-2011-12-400630. 119(23):5591-5598. Epub 2012 APR 10. PMC3369691

78. Cook RJ, Wang Z, Arora M, Lazarus HM, Kasow KA, Champagne MA, Saber W, van Besien KM, Hale GA, Copelan EA, Elmongy M, Ueno NT, Horn BN, Slavin S, Bishop MR, Stadtmauer EA. Clinical outcomes of patients with desmoplastic small round cell tumor of the peritoneum undergoing autologous HCT: a CIBMTR retrospective analysis. Bone Marrow Transplantation. [Epub ahead of print] doi:10.1038/bmt.2012.57. Epub 2012 APR 02.

79. Preussler J, Denzen EM, Majhail NS. Costs and cost-effectiveness of hematopoietic cell transplantation. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.04.001. Epub 2012 APR 03.

80. Tomblyn MR, Chen M, Kukreja M, Aljurf MD, Al Mohareb F, Bolwell BJ, Cahn JY, Carabasi MH, Gale RP, Gress RE, Gupta V, Hale GA, Ljungman P, Maziarz RT, Storek J, Wingard JR, Young JH, Horowitz MM, Ballen KK. No increased mortality from donor or recipient hepatitis B and/or hepatitis C positive serostatus after related donor allogeneic hematopoietic cell transplantation. Transplant Infectious Disease. [Epub ahead of print] doi:10.1111/j.1399-3062.2012.00732.x. Epub 2012 MAY 01.

81. Veys P, Wynn R, Ahn KW, Samarasinghe S, He W, Bonney D, Craddock J, Cornish J, Davies S, Dvorak C, Duerst R, Gross TG, Kapoor N, Kitko C, Krance R, Leung WH, Lewis VA, Wagner J, Carpenter PA, Eapen M. Impact of immune modulation with in vivo T-cell depletion and myeoablative total body irradiation conditioning regimen on outcomes after unrelated donor transplantation for childhood acute lymphoblastic leukemia.. Blood. [Epub ahead of print] doi:10.1182/blood-2012-01-405795. 119(23):6155-6161. Epub 2012 MAY 09. PMC3383023

82. Spellman SR, Eapen M, Logan BR, Mueller C, Rubinstein P, Setterholm MI, Woolfrey AE, Horowitz MM, Confer DL, Hurley CK. A perspective on the selection of unrelated

donors and cord blood units for transplantation. Blood. 2012 JUL 12; doi:10.1182/blood-2012-03-379032. 120(2):259-265. Epub 2012 MAY 17. PMC3398760

83. Pasquini MC, Voltarelli J, Atkins HL, Hamerschlak N, Zhong X, Ahn KW, Sullivan KM, Carrum G, Andrey J, Bredeson CN, Cairo M, Gale RP, Hahn T, Storek J, Horowitz MM, McSweeney PA, Griffith LM, Muraro PA, Pavletic SZ, Nash RA. Transplants for autoimmune diseases in North America: a report of the Center for International Blood and Marrow Transplant Research (CIBMTR). Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:org/10.1016/j.bbmt.2012.06.003,. Epub 2012 JUN 12.

84. Rocha V, Spellman S, Zhang MJ, Ruggeri A, Purtill D, Brady C, Baxter-Lowe LA, Baudoux E, Bergamaschi P, Chow R, Freed B, Koegler G, Kurtzberg J, Larghero J, Lecchi L, Nagler A, Navarette C, Prasad V, Pouthier F, Price, T, Ratanatharathorn V, van Rood JJ, Horowitz MM, Gluckman E, Eapen M. Effect of HLA-matching recipients to donor non-inherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy.. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.07.010. Epub 2012 JUL 16.

85. Horan J, Wang T, Wang T, Haagenson M, Spellman SR, Dehn J, Eapen M, Eapen M, Frangoul H, Gupta V, Hale GA, Hurley CK, Marino S, Oudshoorn M, Reddy V, Shaw P, Lee SJ, Woolfrey A. Evaluation of HLA matching in unrelated hematopoietic stem cell transplantation for nonmalignant disorders.. Blood. [Epub ahead of print] doi:10.1182/blood-2012-03-417758. Epub 2012 JUL 24.

86. Buchbinder D, Nugent DJ, Brazauskas R, Wang Z, Aljurf MD, Cairo MS, Chow R, Duncan C, Eldjerou LK, Gupta V, Hale GA, Halter J, Hayes-Lattin BM, Hsu JW, Jacobsohn DA, Kamble RT, Kasow KA, Lazarus HM, Mehta P, Myers KC, Parsons SK, Passweg JR, Pidala J, Reddy V, Sales-Bonfim CM, Savani BN, Seber A, Sorror ML, Steinberg A, Wood WA, Wall DA, Winiarski JH, Yu LC, Majhail NS. Late effects in hematopoietic cell transplant recipients with acquired severe aplastic anemia: a report from the Late Effects Working Committee of the Center for International Blood and Marrow Transplant Research.. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.06.018. Epub 2012 JUL 31.

87. Petersdorf EW, Malkki M, Gooley TA, Spellman S, Haagenson M, Horowitz MM, Horowitz MM, Wang T. MHC-resident variation affects risks after unrelated donor hematopoietic cell transplatation.. Science Translational Medicine. 2012 JUL 25; doi:10.1126/scitranslmed.3003974. 4(144):144ra101.

88. Weisdorf D, Zhang MJ, Zhang MJ, Arora M, Arora M, Horowitz MM, Horowitz MM, Rizzo JD, Rizzo JD, Eapen M, Eapen M. Graft vs. host disease induced graft vs. leukemia effect: greater impact on relapse and disease-free survival following reduced

intensity conditioning. . Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.06.014. Epub 2012 JUL 02.

89. Majhail NS, Mau L-W, Denzen E, Arneson T. Costs of autologous and allogeneic hematopoietic cell transplantation in the United States: a study using a large national private claims database.. Bone Marrow Transplantation. [Epub ahead of print] doi:10.1038/bmt.2012.133. Epub 2012 JUL 09.

90. Venstrom JM, Pittari G, Gooley TA, Chewning J, Spellman S, Haagenson M, Gallagher MM, Malkki M, Petersdorf EW, DuPont B, Hsu KC. HLA-C-Dependent Prevention of Leukemia Relapse by Donor Activating KIR2DS1.. New England Journal of Medicine . 2012 AUG 30; doi:10.1056/NEJMoa1200503. 367(9):805-816.

91. Paunić V, Gragert L, Madbouly A, Freeman J, Maiers M. Measuring Ambiguity in HLA Typing Methods. PloS one. 2012;7(8):e43585.

92. Danner-Koptik KE, Majhail NS, Brazauskas R, Wang Z, Buchbinder D, Cahn JY, Dilley KJ, Frangoul HA, Gross TG, Hale GA, Hayashi RJ, Hijiya N, Kamble RT, Lazarus HM, Marks DI, Reddy V, Savani BN, Warwick AB, Wingard JR, Wood WA, Sorror ML, Jacobsohn DA. Second malignancies after autologous hematopoietic cell transplantation in children.. Bone Marrow Transplantation. [Epub ahead of print] doi:10.1038/bmt.2012.166. Epub 2012 SEP 10.

93. Keating A, DaSilva G, Perez WS, Gupta V, Cutler CC, Ballen KK, Cairo MS, Camitta BM, Champlin RE, Gajewski JL, Lazarus HM, Lill M, Marks DI, Nabhan C, Schiller GJ, Socie G, Szer J, Tallman MS, Weisdorf DJ. Autologous blood cell transplantation versus HLA-identical sibling transplantation for acute myeloid leukemia in first complete remission: A registry study from the Center for International Blood and Marrow Transplant Research. Haematologica. [Epub ahead of print] doi:10.3324/haematol.2012.062059 . Epub 2012 SEP 14.

94. Bacher U, Klyuchnikov E, Le-Rademacher J, Carreras J, Armand P, Bishop MR, Bredeson CN, Cairo MS, Fenske TS, Freytes CO, Gale RP, Gibson J, Isola LM, Inwards DJ, Laport GG, Lazarus HM, Maziarz RT, Wiernik PH, Schouten HC, Slavin S, Smith SM, Vose JM, Waller EK, Hari PN. Conditioning regimens for allotransplants for diffuse large B-cell lymphoma :myeloablative or reduced intensity?. Blood. [Epub ahead of print] doi:10.1182/blood-2012-06-436725. Epub 2012 SEP 24.

95. Scheike TH, Maiers MJ, Rocha V, Zhang MJ. Competing risks with missing covariates: effect of haplotypematch on hematopoietic cell transplant patients.. Lifetime Data Analysis. [Epub ahead of print] Epub 2012 SEP 12.

96. Logan BR, Zhang MJ. The use of group sequential designs with common competing risks tests.. Statistics in Medicine. [Epub ahead of print] doi:10.1002/sim.5597. Epub 2012 SEP 04.

97. Tracey J, Zhang MJ, Thiel E, Sobocinski KA, Eapen M. Transplant conditioning regimens and outcomes after allogeneic hematopoietic cell transplantation in children and adolescents with acute lymphoblastic leukemia. Biology of Blood & Marrow Transplantation. 2012 Oct 3; . doi:1016/j.bbmt.2012.09.019. Epub 2012 OCT 3.

98. Denzen EM, Majhail NS, Stickney Ferguson S, Anasetti C, Bracey A, Burns L, Champlin R, Chell J, Leather H, Lill M, Maziarz RT, Medoff E, Neumann J, Schmit-Pokorny K, Snyder EL, Wiggins L, Yolin Raley DS, Murphy EA. Hematopoietic Cell Transplantation in 2020: Summary of Year 2 Recommendations of the National Marrow Donor Program's System Capacity Initiative. Biology of Blood & Marrow Transplantation. 2013 Jan 1; 19(1):4-11. doi:doi.org/10.1016/j.bbmt.2012.10.005. Epub 2012 OCT 15.

99. Logan BR. A review of multistate models in hematopoietic cell transplantation studies. Biology of Blood & Marrow Transplantation. 2012 Oct 16; . doi:10.1016/j.bbmt.2012.10.016. Epub 2012 OCT 16.

100. Petz LD, Redei I, Bryson Y, Regan D, Kurtzberg J, Shpall E, Gutman J, Querol S, Clark P, Tonai R, Santos S, Bravo A, Spellman S, Gragert L, Rossi J, Li S, Li H, Senitzer D, Zaia J, Rosenthal J, Forman S, Chow R. Hematopoietic cell transplantation with cord blood for cure of HIV infections. Biology of Blood & Marrow Transplantation. 2013 Mar 1; 19(3):393-7. doi:10.1016/j.bbmt.2012.10.017. Epub 2012 OCT 23.

101. Pulsipher MA, Chitphakdithai P, Logan BR, Shaw BE, Wingard JR, Lazarus HM, Waller EK, Seftel M, Stroncek DF, Lopez AM, Maharaj D, Hematti P, O'Donnell PV, Loren AW, Leitman SF, Anderlini P, Goldstein SC, Levine JE, Navarro WH, Miller JP, Confer DL. Acute toxicities of unrelated bone marrow versus peripheral blood stem cell donation: results of a prospective trial from the National Marrow Donor Program Blood. 2012 Oct 29; . doi:10.1182/blood-2012-03-417667. Epub 2012 OCT 29.

102. Vierra-Green C, Roe D, Hou L, Hurley CK, Rajalingam R, Reed E, Lebedeva T, Yu N, Stewart M, Noreen H, Hollenbach JA, Guethlein LA, Wang T, Spellman S, Maiers M.. Allele-Level Haplotype Frequencies and Pairwise Linkage Disequilibrium for 14 KIR Loci in 506 European-American Individuals. PLoS One. 2012 Nov 5; 7(11):e47491. doi:10.1371/journal.pone.0047491. Epub 2012 NOV 5. PMC3489906.

103. Maramattom LV, Hari PN, Burns LJ, Carreras J, Arcese W, Cairo MS, Costa LJ, Fenske TS, Lill M, Freytes CO, Gale RP, Gross TG, Hale GA, Hamadani M, Holmberg LA, Hsu JW, Inwards DJ, Lazarus HM, Marks DI, Maloney DG, Maziarz RT, Montoto S, Rizzieri DA, Wirk B, Gajewski JL. Autologous and allogeneic transplantation for burkitt lymphoma outcomes and changes in utilization: a report from the Center for International Blood and Marrow Transplant Research. Biology of Blood & Marrow Transplantation. 2012 Nov 27; . doi:10.1016/j.bbmt.2012.11.016. Epub 2012 NOV 27.

104. Scaradavou A, Brunstein CG, Eapen M, Le-Rademacher J, Barker JN, Chao N, Cutler C, Delaney C, Kan F, Isola L, Karanes C, Laughlin MJ, Wagner JE, Shpall EJ. Double unit grafts successfully extend the application of umbilical cord blood transplantation in adults with acute leukemia Blood. 2012 Dec 9; . doi:10.1182/blood-2012-08-449108. Epub 2012 DEC 9.

105. Akpek G, Pasquini MC, Logan B, Agovi M-A, Lazarus HM, Marks DI, Bornhaeüser M, Ringdén O, Maziarz RT, Gupta V, Popat U, Maharaj D, Bolwell J, Rizzo JD, Ballen KK, Cooke KR, McCarthy PL, Ho VT. Effects of spleen status on early outcomes after hematopoietic cell transplantation. Bone Marrow Transplantation. . doi:10.1038/bmt.2012.249. Epub 2012 DEC 10. PMC3606905.

106. de Lima M, McNiece I, Robinson SN, Munsell M, Eapen M, Horowitz M, Alousi A, Saliba R, McMannis JD, Kaur I, Kebriaei P, Parmar S, Popat U, Hosing C, Champlin R, Bollard C, Molldrem JJ, Jones RB, Nieto Y, Andersson BS, Shah N, Oran B, Cooper LJN, Worth L, Qazilbash MH, Korbling M, Rondon G, Ciurea S, Bosque D, Maewal I, Simmons PJ, Shpall EJ. Cord blood engraftment with ex-vivo mesenchymal cell co-culture. New England Journal of Medicine. 2012 Dec 13; 367(24):2305-2315. doi:10.1056/NEJMoa1207285.

Abstracts

1. Brunstein CG, Carter S, Fuchs EJ, Karanes C, Devine S, O Aljitawi O, Cutler C, Ballen KK, Thompson J, O'Donnell PV, Eapen M. Brunstein CG, Carter S, Fuchs EJ, Karanes C, Devine S, O Aljitawi O, Cutler C, Ballen KK, Thompson J, O'Donnell PV, Eapen M. Phase II Trial of non-myeloablative conditioning (NST) double umbilical cord blood transplantation (DUCBT) from unrelated donors in patients with hematologic malignancies: results of Blood and Marrow Transplant Clinical Trials Network (BMT CTN) Protocol 0604. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S151. Abstract 4.

2. Fuchs EJ, Wu J, Carter S, Brunstein C, Costa L, Wingard J, Jagasia M, D'Elia J, Eapen M, O'Donnell PV. Phase II trial of non-myeloablative conditioning and transplantation of partially HLA-mismatched (HLA-haploidentical) bone marrow (BMT) for patients with hematologic malignancies: Results of BMT CTN protocol #0603. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S151 Abstract 5.

3. Hurley C, Klein J, Spellman S, Haagenson M, Lee SJ, Askar M, Baxter-Lowe LA, He J, Hsu S, Blasczyk R . Scoring HLA mismatches by Histocheck does not predict clinical outcome in HCT. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S172. Abstract 55

4. Kawase T, Morishima Y, Malkki M, Gooley TA, Hsu KC, Dupont B, Bardy P, Madigral A, Bignon J-D, Spellman S, Velardi A and Petersdorf EW. Universal role for HLA-C and KIR2DL ligand mismatch in severe acute graft-versus-host disease after unrelated

donor hematopoietic stem cell transplantation (U-HSCT) in Japanese and Caucasian transplant recipients: an analysis on behalf of International Histocompatibility Working Group in hematopoietic cell transplantation. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S165. Abstract 37.

5. Majhail NS, Quinn G, Brazauskas R, Wang Z, Chow E, Gilleece M, Halter J, Joshi S, Pidala J, Bolwell B, Jacobsohn D, Socie G, Sorror M, Wingard JR, Rizzo JD, Loren A. Transplant physician perceptions and practice patterns regarding fertility preservation in hematopoietic-cell transplant (HCT) recipients. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S240. Abstract 235.

6. Venstrom JM, Pittari G, Chewning J, Gooley TA, Spellman S, Haagenson M, Gallagher MM, Malkki M, Petersdorf E, Dupont B, Hsu KC. Donor KIR2DS1 and KIR3DS1 are associated with improved outcomes following unrelated allogeneic stem cell transplantation for acute myeloid leukemia. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S156. Abstract 16.

7. Woolfrey A, Horan J, Wang T, Haagenson M, Ayas M, L Baxter-Lowe LA, Bielorai B, Davies S, Dehn J, Frangoul H, Gajewski J, Gupta V, Hale GA, Hurley C, Marino S, McCarthy P, Orchard P, Oudshoorn M, Pollack MS, Reddy V, Shaw PJ, Spellman S, Lee S. Evaluation of HLA matching requirements in unrelated hematopoietic stem cell transplantation for nonmalignant disorders. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]:S173. Abstract 56.

8. Boo M, Ballen K, Maiers M. Cord blood unit access and selection: 2010 and beyond: best practices and emerging trends in cord blood unit selection. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S46-51.

9. T. Kawase, Y. Morishima, M. Malkki, T.A. Gooley, K.C. Hsu, B. Dupont, P. Bardy, A. Madigral, J.-D. Bignon, S. Spellman, A. Velardi, E.W. Petersdorf. Universal Role for HLA-C and KIR2Dl Ligand Mismatch in Severe Acute Graft-Versus-Host Disease After Unrelated Donor Hematopoietic Stem Cell Transplantation (U-HSCT) in Japanese and Caucasian Transplant Recipients: An Analysis on Behalf of International Histocompatibility Working Group in Hematopoietic Cell Transplantation. Biology of Blood and Marrow Transplantation 2011; 17(2) [Suppl 2]: S165.

10. V. Rocha , D. Purtill , M. Zhang , S. Spellman , A. Ruggeri , V. Prasad , C. Navarette , G. Koegler , E. Baudoux , L. Lecchi , L.A. Baxter-Lowe , M. Horowitz , van Rood JJ, Kurtzberg J, Gluckman E, Eapen M. Impact of matching at non-inherited maternal antigens on outcomes after 5/6 or 4/6 HLA mismatched unrelated cord blood transplantation for malignant haematological diseases. A matched pair analysis on behalf of Eurocord, Netcord, NMDP, IBMTR. Bone Marrow Transplantation 2011; 46(suppl 1):S2 (abst no O115).

11. Crotta , V. Rocha , M. Eapen , J.E. Wagner , M.L. MacMillan , M. Zecca , J. Kurtzberg , C. Bonfi m , A. Vora , C. Díaz de Heredia , M. Mohty , L. Teague 0, J. Stein , T.A. O'Brien , H. Bittencourt , A. Madureira , C. Peters , C. Niemeyer , E. Gluckman , F. Locatelli Analysis of risk factors influencing outcomes after unrelated cord blood transplantation in children with juvenile myelomonocytic leukaemia. An Eurocord, EBMT, EWOGMDS, CIBMTR Study. Bone Marrow Transplantation 2011; 46(suppl 1):S13 (abst no O169).

12. R. Olsson, B. Logan, J. Schriber, X. Zhu, O. Ringden, K. Cooke, V. Ho, P. McCarthy, M. Agovi, S. Chaudhury, M. Pasquini on behalf of the CIBMTR Regimen Related Toxicity/Supportive Care Working Committee Patients at risk for primary graft failure after allogeneic haematopoietic cell transplantation with myeloablative conditioning. Bone Marrow Transplantation 2011; 46(suppl 1):S18 (abst no O175).

13. Jacobsohn , K. Danner-Koptik , R. Brazauskas , Z. Wang , C. Duncan , M. Sorror , N. Majhail Second malignancies after autologous haematopoietic stem cell transplantation in children. Bone Marrow Transplantation 2011; 46(suppl 1):S20 (abst no O180).

14. P. Veys, K.W. Ahn, S. Samarasinghe, J. Craddock, W. He, J. Cornish, J. Moppett, S. Davies, C. Dvorak, R. Duerst, T. Gross, C. Kitko, W. Leung, V. Lewis, R. Wynn, P. Carpenter, M. Eapen on behalf of CIBMTR Working Committee for Pediatric Cancer Impact of immune modulation with anti-T cell antibodies on outcomes after unrelated donor transplantation for acute lymphoblastic leukaemia in children and adolescents. Bone Marrow Transplantation 2011; 46(suppl 1):S2 (abst no O400).

15. Fleischhauer K, Wang T, Spellman S, Crivello P, Haagenson M, Battiwalla M, Baxter-Lowe LA, Dehn JW, Gajewski JL, Hale GA, M. B. Heemskerk MB, Lee SJ, McCarthy PL, Miklos DK, Oudshoorn M, Pollack MS, Marino S, Reddy V, Senitzer D, Shaw B, Waller EK, Fernandez-Vina M. No apparent contribution of HLA-DPA1 to the significantly increased risk for non-relapse mortality associated with non-permissive donor-recipient HLA-DPB1 T cell epitope disparities in unrelated stem cell transplants facilitated through the National Marrow Donor Program. Tissue Antigens 77(5): 397. Abstract P4.

16. Gragert L, Williams E, Madbouly A, Maiers M, Oudshoorn M. High-resolution HLA A-B-DRB1 haplotype frequencies for BMDW registries. Tissue Antigens 2011; May 77(5): 409-410.

17. Toropovskiy A, Gragert L, Kluchnikov D, Trusova L, Epifanova A, Gilmutdinov R, Tyumina O. Analysis of high resolution haplotype frequencies in Samara and Orenburg population of Russia. Tissue Antigens 2011; May 77(5): 414-414.

18. Dehn J, Buck K, Setterholm M, Yang SY, Schmidt A, Confer D. Efficiency of strategic donor selection to identify an 8/8 high resolution match. Tissue Antigens 2011; May 77(5): 408.

19. Kempenich JH, Dehn J, Flickinger G, Setterholm M, Yu N, Masaberg C, Shields B, Koester R, Yang SY, Shi W, Nichol L, Hsu S. Functional validation of rare HLA alleles. Tissue Antigens 2011; May 77(5): 417–418.

20. Brady C, Brown M, Eapen M, Rocha V, Baxter-Lowe LA, Prasad VK, Kurtzberg J, Spellman S. The influence of HLA antigen/allele frequency on access to non-inherited maternal antigens (NIMA) for recipients of cord blood transplant. Best Poster Abstract. Presented at the 9th Annual Umbilical Cord Blood Symposium, San Francisco, June 23-25, 2011.

21. Dobbelstein C, Haagenson M, Ahn KW, Spellman S, Fernandez-Vina M, Eder M Ganser A, Lee SJ. Birth order is not a major factor influencing transplant outcome in HLA-identical sibling SCT – an analysis on behalf of the CIBMTR. Presented at the 2011 European Hematology Association Meeting, London, June 2011.

22. Vierra-Green C, et al. Refinement of KIR high-resolution haplotypes and patterns of linkage disequilibrium in Caucasians. Presented at the KIR Workshop, Tammsvik, Sweden, June 3-6, 2011.

23. Koreth J, Pidala J, Perez WS, Deeg HJ, Garcia-Manero G, Malcovati L, Cazzola M, Park S, Itzykson R, Ades L, Fenaux P, Jädersten M, Hellstrom-Lindberg E, Gale RP, Beach CL, Greenberg PL, Tallman MS, DiPersio JF, Bunjes D, Weisdorf DJ, Cutler CS. A decision analysis of reduced-intensity conditioning allogeneic hematopoietic stem cell transplantation for older patients with de-novo myelodysplastic syndrome (MDS): early transplantation offers survival benefit in higher-risk MDS. Blood. 2011 118(21): Abstract O115.

24. Battiwalla M, Ellis K, Pavletic SZ, Akpek G, Hematti P, Klumpp TR, Maziarz RT, Savani BN, Aljurf M, Cairo MS, Drobyski WR, George B, Hahn T, Khera N, Litzow MR, Loren AW, Saber W, Arora M, Urbano-Ispizua A, Cutler CS, Flowers MED, Spellman S. HLA DR15 antigen status does not impact graft-versus-host disease or disease-free survival in HLA-matched sibling transplantation for hematologic malignancies. Blood. 2011 118(21): Abstract P3094.

25. Cook RJ, Wang Z, Arora M, Lazarus HM, Kasow KA, Champagne MA, Saber W, Van Besien KM, Hale G, Copelan EA, Elmongy M, Ueno, NT Horn BN, Slavin S, Stadtmauer EA. Is there a role for ASCT in patients with desmoplastic small round cell tumor of the peritoneum? Blood. 2011 118(21): Abstract P3092.

26. Hale G, Grupp, S Kasow K, Davies S, Hussein A, Childs R, Jodele S, Myers K, Stiff P, He W, Ahn KW, Copelan E, Lewis V, Bitan M, Cairo M, Horn B, Qayed M, Pulsipher M, Soni S, Chan K, Diaz MA, Kamani N, Kletze M, Shaw P, Bishop MR, Stadtmauer E, Ueno NT, Gonzalez VM, Lazarus H, Doyle J, Camitta B, Gale R, Sanders J, Wall D, Arora M, for the Solid Tumor and Pediatric Cancer Working Committees of the

CIBMTR. Allogeneic hematopoietic cell transplantation (HCT) for neuroblastoma (NB): the CIBMTR experience. Blood. 2011 118(21): Abstract P3074.

27. Hahn T, McCarthy PL, Jr., Carreras J, Zhang MJ, Lazarus HM, Laport GG, Montoto S, Maloney DG, Hari P. A CIBMTR prognostic model for progression-free survival (PFS) after autologous hematopoietic cell transplantation (AHCT) for relapsed or refractory Hodgkin lymphoma (HL). Blood. 2011 118(21): Abstract O499.

28. Warlick ED, McClune B, Pedersen TL, Awn KW, Antin JH, Cahn JY, DeLima M, Gupta V, Marks DI, Bunjes D, DiPersio JF, Devine S, Weisdorf DJ. Older adults with chronic myelogenous leukemia (CML), during the tyrosine kinase inhibitor (TKI) era, can be successfully treated with reduced intensity conditioning (RIC) hematopoietic cell transplant (HCT) using sibling or unrelated donors: a Center for International Blood and Marrow Transplant Research (CIBMTR) analysis. Blood. 2011 118(21): Abstract O494.

29. Bacher U, Klyuchnikov E, Carreras J, Le-Rademacher J, Laport GG, Montoto S, , Maloney DG, Hari P. Conditioning intensity in allogeneic hematopoietic cell transplantation (alloHCT) for diffuse large B-cell lymphoma (DLBCL). Blood. 2011 118(21): Abstract O501.

30. Saad AA, Vesole DH, Le-Rademacher J, Zhong X, Dispenzieri A, Lonial S, Milone GA, Hari P. Second autologous transplants for multiple myeloma (MM) relapse after a prior autologous transplant (AHCT) – a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood. 2011 118(21): Abstract O504.

31. Freytes CO, Vesole DH, Zhong X, Le-Rademacher J, Dispenzieri A, Lonial S, Milone G, Hari P. Second transplants in relapsed multiple myeloma (MM): autologous (AHCT) versus non-myeloablative/reduced intensity (NST/RIC) allogeneic transplantation (AlloHCT). Blood. 2011 118(21): Abstract O824.

32. Ayas M, Le-Rademacher J, Deeg HJ, Gale RP, Davies SM, Bajwa RPS, Battiwalla M, Slavin S, Camitta B, Bierings MB, Harris RE, Olsson R, Wirk B, George B, Bonfim C, Saber W. Results of allogeneic hematopoietic cell transplantation in persons with Fanconi anemia and pretransplant cytogenetic abnormalities, myelodysplastic syndrome, or acute leukemia. Blood. 2011 118(21): Abstract O838.

33. McClune B, Pedersen TL, Ahn KW, Warlick ED, Pidala J, Waller EK, Rizzo JD, Cairo MS, Woolfrey A, Artz A, Lazarus HM, Weisdorf DJ. Reduced intensity or non-ablative hematopoietic cell transplantation in older patients with non-Hodgkin lymphoma (NHL): encouraging survival for patients ≥55 years. Blood. 2011 118(21): Abstract O1015.

34. Weisdorf DJ, Zhang MJ, Arora M, Rizzo JD, Horowitz MM, Eapen M. Graft-versus-host disease (GVHD) induced graft-versus-leukemia (GVL) effect: more impact on later relapse and disease-free survival following reduced intensity conditioning. Blood. 2011 118(21): Abstract O1014.

35. Eckrich MJ, Ahn KW, Wang Z, Deeg HJ, Horowitz MM, Eapen M. Effect of race on outcomes after allogeneic hematopoietic cell transplantation for severe Aplastic Anemia. Blood. 2011 118(21): Abstract O1020.

36. Leis J, Sabloff M, Sobecks R, Maziarz R, Ahn KW, Zhu X, Kalaycio M, Cortes J, Saber W on behalf of the CIBMTR Chronic Leukemia Working Committee. Outcomes of allogeneic hematopoietic cell transplantation (HCT) in chronic lymphocytic leukemia (CLL): impact of myeloablative (MA) vs. reduced-intensity conditioning (RIC) regimens, and impact of total body irradiation (TBI)-based MA versus chemotherapy (CT)-based MA conditioning. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P175.

37. Bredeson C, Burkart J, Zhu X, Sun Y, LeRademacher J, Pasquini M, Armstrong E, Rizzo JD, Kato K. Chimerism testing with reduced intensity intravenous Busulfan-based conditioning regimens: once is enough. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P182.

38. Bredeson C, Burkart J, Sun Y, Zhu X, LeRademacher J, Rizzo JD, Armstrong E, Pasquini M, Kato K. Dose, schedule and PK practices with IV busulfan-based conditioning regimens in a non-inferiority trial: heterogenous practices but low VOD and TRM. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P208.

39. Pederson KA, Rizzo JD, Hahn T, Lee SJ, McCarthy PL, Ammi MS, Denzen EM, Drexler R, Flesch SM, James H, Omondi NA, Pedersen TL, Murphy EA, Majhail NS. Patient and Family Out-of-Pocket Costs of Allogeneic Hematopoietic Cell Transplantation (HCT): A Pilot Study. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O211.

40. Tomblyn M, Trifilio S, Chen M, Klein J, Boeckh M, Gea-Banacloche J, Szabolcs P, Bennett C, on behalf of the CIBMTR Infection and Immune Reconstitution Working Committee. Risk Factors and Outcomes in patients with Atypical Mold Infection (AMI)following Allogeneic Hematopoietic Cell Transplantation (HCT): A CIBMTR Analysis from the Infection and Immune Reconstitution Working Committee. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O261.

41. Hong S, Barker C, John P Klein JP1, Peter Shaw P, Bredeson C, Angelina A, Rowlings P, Cahn JY, Kharfan-Dabaja M, Aljurf M, Szer J, Wood WA, Ahmed I, Gomez-Almaguer D, Atsuta Y, Pasquini MC and on behalf of the CIBMTR International Studies Committee. Trends in Utilization of Total Body Irradiation (TBI) Prior to Hematopoietic Cell Transplantation (HCT) Worldwide. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O293.

42. Giglio F, Venstrom JM, Gooley TA, Gallagher MM, Hou L, Hurley CK, Lebedeva T, Noreen H, Rajalingam R, Reed EF, Vierra-Green C, Yu N, Haagenson M, Spellman S, Malkki M, Petersdorf E, Hsu KC. KIR3DL1/S1 and HLA-B alleles combine to influence

unrelated hematopoietic stem cell transplantation (HSCT) outcomes. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O309.

43. Buchbinder D, Nugent D, Brazauskas R, Wang Z, Aljurf M, Cairo MS, Chow R, Duncan C, Eldjerou LK, Gupta V, Hale GA, Halter J, Hayes-LattinBM, Hsu JW, Jacobsohn DA, Kamble RT, Kasow KA, Lazarus HM, Mehta P, Myers KC, Parsons SK, Passweg JR, Pidala J, Reddy V, Sales-Bonfim CM, Savani BN, Seber A, Sorror ML, Steinberg A, Wood WA, Wall DA, Winiarski JH, Yu LC, Majhail NS. Late effects in hematopoietic cell transplant recipients with acquired severe Aplastic Anemia: a report from the Late Effects Working Committee of the Center for International Blood and Marrow Transplant Research (CIBMTR). Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O316.

44. Majhail NS, Mau LW, Denzen E, Arneson TJ. Costs of hospitalization for hematopoietic cell transplantation (HCT) in the United States (U.S.): a pilot study using a large national commercial payor database. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O317.

45. Boyiadzis M, Klein JP, Arora M, Weisdorf DJ, Hassebroek A, Lee SJ, Flowers ME, Cutler CS, Urbano-Ispizua A, Antin JH, Bolwell BJ, Cahn JY, Cairo MS, Gale RP, Herzig RH, Isola LM, Jacobsohn DA, Jagasia MH, Klumpp TR, Petersdorf EW, Wingard JR, Horowitz MM, Pavletic SZ. Impact of chronic GVHD on late relapse, treatment related mortality and survival after allogeneic hematopoietic cell transplantation for hematological malignancies. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O436.

46. Aplenc R, Pasquini MC, Zhang MJ, Zhu X, McCarthy P, Ho VT, Cooke K, Sung L, Bunin N, On behalf of the CIBMTR Regimen Related Toxicity and Supportive Care Working Committee. Effects of body mass index (BMI) in children undergoing allogeneic bone marrow transplant (BMT) for hematologic malignancies. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O444.

47. Barker CA, Hong S, Klein JP, Shaw P, Bredeson C, Angelina A, Rowlings P, Cahn JY, Kharfan-Dabaja M, Aljurf M, Szer J, Wood WA, Ahmed I, Gomez Almaguer D, Atsuta Y, Sanz M, Hale G, Litzow M, Pasquini MC and on behalf of the CIBMTR International Studies Committee. Radiotherapeutic techniques in allogeneic hematopoietic cell transplant (HCT). Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O448.

48. Milius RP, Shabo A, Pollack J, et al. HL7 implementation of silver standard principles for reporting HLA typing. Tissue Antigens 2012; 79(6): Abstract P279.

49. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Tissue Antigens 2012; 79(6): Abstract P281.

50. Paunic V, Gragert L, Madbouly A, Freeman J, Maiers M. Shannon's entropy as a measure of in silico HLA typing ambiguity reduction using population haplotype frequencies. Tissue Antigens 2012; 79(6): Abstract P284.

51. Leahy N, Halagan M, Gragert L, Madbouly A, Maiers M. Automated HLA haplotype identification with typing inference from extended families. Tissue Antigens 2012; 79(6): Abstract P286.

52. Groeneweg M, Voorter CEM, Martin Maiers M, Tilanus MGJ. Analysis of extended polymorphisms In the exons of HLA and KIR genes: the polymorphic index of the peptide binding groove and beyond. Tissue Antigens 2012; 79(6): Abstract P290.

53. Gourraud PA, Cereb N, Yang SY, et al. Reshaping the MHC genetic contribution tomultiple sclerosis: an association study

54. of high resolution HLA-A, HLA-B, HLA-C, HLA-DRB1, HLA-DQB1 in European and African American multiple sclerosis patients

55. Lazaro AM, Henry J, Xiao Y, Ng J, Hurley CK, Posch PE. Novel alleles, far from the finish line. Tissue Antigens 2012; 79(6): Abstract P321.

56. Roers B, Jones L, Heinke C, Fritch R, Setterholm M. Stored donor samples in the NMDP repository accelerate search activity timelines: use of stored samples saves 9 days for the patient searches. Presented at the WMDA International Donor Registry Conference, May 3-5, 2012, Sydney, Australia.

57. Dehn J, Kempenich J, Maiers M, Fernandez-Vina MA, Setterholm M. HLA-C DNA typed antigens frequently missed by prior serology. Presented at the WMDA International Donor Registry Conference, May 3-5, 2012, Sydney, Australia.

58. Kempenich J, Dehn J, Setterholm M. Inaccuracy of HLA-DRB1*16:08. Tissue Antigens 2012; 79(6): Abstract P41.

59. Marino SR, Lee SM, Haagenson M, Binkowski TA, Spellman S, Lee SJ, Karrison T. Identification of non-permissive amino acid substiutions associated with one year overall survival in hematopoetic stem cell transplantation. Tissue Antigens 2012; 79(6): Abstract P19.

60. Hurley et al. Impact of HLA unidirectional mismatches on the outcome of unrelated donor hematopoietic stem cell transplantation. Tissue Antigens 2012; 79(6): Abstract O12.

61. Ehab Atallah, Tanya Pedersen, Erica Warlick, Anne Dircks, Daniel Weisdorf, Mary Horowitz, J. Douglas Rizzo. The outcome of Hematopoietic Cell Transplantation (HCT) for Myelodysplastic Syndrome (MDS) in adults ≥ 65 years of age: first report of the

Coverage with Evidence Development (CED) in medicare beneficiaries. Blood 2012. 120(21): Abstract P1983.

62. Johann K. Hitzler, Wensheng He, John J Doyle, Menachem Bitan, Mitchell S. Cairo, Bruce Camitta, Ka Wah Chan, Miguel Angel Diaz, Christopher Fraser, Thomas Gross, John T. Horan, Kimberly A. Kasow, Alana Kennedy-Nasser, Carrie Kitko, Joanne Kurtzberg, Leslie E. Lehmann, David Mitchell, Tracey O'Brien, GradDip, Michael A. Pulsipher, Franklin O. Smith, Lolie C. Yu, Mei-Jie Zhang, Mary Eapen, and Paul A. Carpenter. Outcome of transplantation for acute Leukemia in down syndrome. Blood 2012. 120(21): Abstract P1991.

63. "Edward A. Copelan, Betty K. Hamilton, Kwang W Ahn, PhD, Xiaochun Zhu, Belinda Avalos, Brian J. Bolwell, Robert Peter Gale, Jorge E Cortes, Matt E. Kalaycio, Richard T. Maziarz, and Wael Saber.

64. Lower transplant-related mortality and improved survival for patients with AML in first CR receiving BuCy compared to Cy/TBI as myeloablative preparation for allogeneic transplantation: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O217."

65. Michael J. Kelly, John T. Horan, Todd A. Alonzo, Mary Eapen, Robert B. Gerbing, Wensheng He, Beverly J. Lange, Susan K. Parsons, and William G. Woods. Hematopoietic cell transplant versus chemotherapy as consolidation treatment for pediatric AML with poor-risk cytogenetics. Blood 2012. 120(21): Abstract O127.

66. Susana R. Marino, Sang M Lee, T Andrew Binkowski, Michael D Haagenson, Martin Maiers, Stephen Spellman, Koen van Besien, Stephanie J Lee, Theodore Karrison, and Andrew Artz. Identification of high risk HLA Class I amino acid substitutions in hematopoietic stem cell transplantation Blood 2012. 120(21): Abstract P3050.

67. Wael Saber, Corey Cutler, Ryotaro Nakamura, Mei-Jie Zhang, Ehab Atallah, J. Douglas Rizzo, Richard T. Maziarz, Jorge E Cortes, Matt Kalaycio, and Mary M. Horowitz. Comparison of outcomes after related and unrelated hematopoietic cell transplantation in adults with myelodysplastic syndromes: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O355.

68. Fabio Giglio, Ted A. Gooley, Jeffrey M. Venstrom, Meighan M. Gallagher, LiHua Hou, Carolyn K. Hurley, Tatiana Lebedeva, Harriet Noreen, Raja Rajalingam, Elaine F. Reed, Neng Yu, Cynthia Vierra-Green, Michael Haagenson, Mari Malkki, Effie Petersdorf, Stephen Spellman, Katharine C. Hsu. Donor KIR3DL1 and HLA-B allotypes control leukemia relapse after allogeneic hematopoietic stem cell transplantation. Blood 2012. 120(21): Abstract O349.

69. Joseph Pidala, Tao Wang, Michael D Haagenson, Stephen Spellman, Medhat Askar, Minoo Battiwalla, Lee Ann Baxter-Lowe, Menachem Bitan, Marcelo Fernandez-Vina,

Manish Gandhi, Ann A Jakubowski, Martin Maiers, Susana R Marino, Steven GE Marsh, Machteld Oudshoorn, Jeanne Palmer, Vinod K. Prasad, Vijay Reddy, Olle Ringden, Wael Saber, Stella Santarone, Kirk R. Schultz, Michelle Setterholm, Elizabeth Trachtenberg, Vicky Turner, Ann Woolfrey, Stephanie J Lee, and Claudio Anasetti. Amino acid substitution at peptide-binding pockets of HLA Class I molecules adversely impacts hematopoietic cell transplantation outcomes. Blood 2012. 120(21): Abstract O467.

70. Mehdi Hamadani, Wael Saber, Jeanette Carreras, Kwang Woo Ahn, Ginna Laport, Silvia Montoto, David Maloney and Hillard Lazarus. Impact of conditioning regimen intensity on the outcomes of allogeneic hematopoietic cell transplantation for refractory Grade-III Follicular (FL-III) and Diffuse Large B-Cell Lymphomas (DLBCL): a CIBMTR analysis. Blood 2012. 120(21): Abstract O473.

71. Vikas Gupta, Kwang W Ahn, Xiaochun Zhu, Zhenhuan Hu, Parameswaran Hari, Richard T. Maziarz, Jorge E Cortes, Matt E. Kalaycio, and Wael Saber. Lille scoring system rather than DIPSS is a better predictive of overall mortality after allogeneic Hematopoietic Cell Transplantation (HCT) for primary myelofibrosis using reduced intensity conditioning: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O432.

72. "Ravi Vij, Xiaobo Zhong, Mei-Jie Zhang, Sagar Lonial, Angela Dispenzieri, and Parameswaran Hari.

73. Pre-transplant salvage therapy prior to Autologous Transplant (AHCT) in patients not responding to initial induction for Multiple Myeloma (MM) Blood 2012. 120(21): Abstract O597."

74. "Girindra Raval, Anuj Mahindra, Xiaobo Zhong, Ruta Brazauskas, Robert Peter Gale, Nancy Brandenburg, Sagar Lonial, Amrita Krishnan, Angela Dispenzieri, and Parameswaran Hari.

75. Second malignancies after Autologous Hematopoietic Cell Transplantation (AHCT) for Multiple Myeloma (MM): A Center for International Blood and Marrow Transplant Research (CIBMTR) Analysis Blood 2012. 120(21): Abstract O591"

76. Mohamed L. Sorror, Brent Logan, J.Douglas Rizzo, Kennneth Cooke, Philip L. McCarthy, Vincent T. Ho, Xiaochun Zhu, Barry Storer, and Marcelo Pasquini. Prospective Validation of the Predictive Power of the Hematopoietic Cell Transplantation Comorbidity Index (HCT-CI) for HCT Outcomes at US Transplant Centers: A Center for International Blood and Marrow Transplant Research (CIBMTR) Study. Blood 2012. 120(21): Abstract O733

77. Monica S Thakar, Brent R. Logan, Marcelo C. Pasquini, Philip L. McCarthy Jr., Vincent T Ho, Kenneth R. Cooke, Xiaochun Zhu, J. Douglas Rizzo, and Mohamed L. Sorror. The

Hematopoietic Cell Transplantation Comorbidity Index (HCT-CI) can prospectively discriminate risks affecting overall survival in pediatric and adult patients with non-malignant diseases Blood 2012. 120(21): Abstract O737

78. Michael Eckrich, Jennifer Le-Rademacher, J. Douglas Rizzo, K. Scott Baker, Deepika Bhatla, David K. Buchbinder, Kenneth R. Cooke, Reggie Duerst, Andrew Gilman, Haydar Frangoul, Neena Kapoor, Nancy A. Kernan, Michael Verneris, Mary Eapen. The Effect of Transplant Center Characteristics On Survival After Pediatric Hematopoietic Cell Transplantation. Blood 2012. 120(21): Abstract O762.

79. Luciano J Costa, Xiaobo Zhong, Mei-Jie Zhang, Sagar Lonial, Amrita Krishnan, Angela Dispenzieri, and Parameswaran Hari. Trends in utilization and outcomes of Autologous Hematopoietic Cell Transplantation (AHCT) in the upfront management of patients with Multiple Myeloma: a CIBMTR analysis Blood 2012. 120(21): Abstract O596.

80. Anuj Mahindra, Ayman A Saad, Mei-Jie Zhang, Xiaobo Zhong, Angela Dispenzieri, Amrita Krishnan, Sagar Lonial, Marcelo C Pasquini, and Parameswaran Hari. Hematopoietic Cell Transplant Co-Morbidity Index (HCTCI) and Multiple Myeloma (MM) survival after Autologous Hematopoietic Cell Transplantation (AHCT) Blood 2012. 120(21): Abstract P4217.

81. Mehdi Hamadani, Wael Saber, Jeanette Carreras, Kwang Woo Ahn, Ginna Laport, Silvia Montoto, David Maloney, and Hillard Lazarus. Effect of graft source and transplant conditioning regimen intensity on the outcomes of allogeneic hematopoietic cell transplantation for refractory Mantle Cell Lymphoma (MCL): A CIBMTR Analysis. Blood 2012. 120(21): Abstract O815.

82. Marcelo C. Pasquini, Brent R. Logan, Vincent T Ho, Philip L. McCarthy Jr., Kenneth R. Cooke, J. Douglas Rizzo, Xiaochun Zhu, and Mohamed L. Sorror.Comorbidity Index (CI) in Autologous Hematopoietic Cell Transplantation (HCT) for malignant diseases: validation of the HCT-CI Blood 2012. 120(21): Abstract O814.